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ABSTRACT

This volume is the eighth in a series of 29 coordinated MINNEMAST units in mathematics and science for kindergarten and the primary grades. Intended for use by first-grade teachers, this unit guide provides a summary and overview of the unit, a list of materials needed, and descriptions of four groups of lessons. The purposes and procedures for each activity are discussed. Examples of questions and discussion topics are given, and in several cases ditto masters, stories for reading aloud, and other instructional materials are included in the book. This unit, concerned with the observation of properties of objects, and the use of these observations in classification and description, includes sections titled: (1) observing and describing properties, (2) sorting sets by properties, (3) testing for properties, and (4) changing and unchanging properties. (SD)

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SE 021 213

UNIT

8

2



MINNESOTA MATHEMATICS AND SCIENCE TEACHING PROJECT

KINDERGARTEN	1. WATCHING AND WONDERING
	2. CURVES AND SHAPES
	3. DESCRIBING AND CLASSIFYING
	4. USING OUR SENSES
	5. INTRODUCING MEASUREMENT
	6. NUMERATION
	7. INTRODUCING SYMMETRY
	● 8. OBSERVING PROPERTIES
FIRST GRADE	9. NUMBERS AND COUNTING
	10. DESCRIBING LOCATIONS
	11. INTRODUCING ADDITION AND SUBTRACTION
	12. MEASUREMENT WITH REFERENCE UNITS
	13. INTERPRETATIONS OF ADDITION AND SUBTRACTION
	14. EXPLORING SYMMETRICAL PATTERNS
SECOND GRADE	15. INVESTIGATING SYSTEMS
	16. NUMBERS AND MEASURING
	17. INTRODUCING MULTIPLICATION AND DIVISION
	18. SCALING AND REPRESENTATION
	19. COMPARING CHANGES
	20. USING LARGER NUMBERS
	21. ANGLES AND SPACE
	22. PARTS AND PIECES
THIRD GRADE	23. CONDITIONS AFFECTING LIFE
	24. CHANGE AND CALCULATIONS
	25. MULTIPLICATION AND MOTION
	26. WHAT ARE THINGS MADE OF?
	27. NUMBERS AND THEIR PROPERTIES
	28. MAPPING THE GLOBE
	29. NATURAL SYSTEMS

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printed TEACHING AIDS for Kindergarten and Grade 1.

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(MINNEMAST Handbook for all grades)

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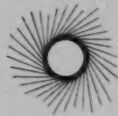
MINNEMAST COORDINATED MATHEMATICS-SCIENCE SERIES

UNIT 8



MINNESOTA MATHEMATICS AND SCIENCE TEACHING PROJECT

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MINNESOTA MATHEMATICS AND SCIENCE TEACHING PROJECT

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University of Minnesota

This unit, Observing Properties, was developed by the MINNEMAST staff from earlier MINNEMAST materials revised in the light of the experience of the many teachers who have tried the activities in the classroom. This trial edition, Unit 8 of the MINNEMAST Coordinated Mathematics-Science Series, was produced under the leadership of:

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Complete List of Materials for Unit 8

(Numbers based on class size of 30.)

total number required to teach unit	item	lessons in which item is used
35	** copies of Student Manual A (The first 7 work-sheets are for this unit; the rest are for Unit 9.)	
35	** Letter to Parent from MINNEMAST Director	
3-5	*** sets of property blocks	3,6,8
1	* fingertip properties kit (6 sets of objects)	3
6	cafeteria trays or shallow boxes	3
30	* small plastic bags	4,7
30	fasteners or rubber bands	4
5-10	plastic or glass containers (for insect cages)	4
30	* hand magnifying lenses	4,12,19
1	MINNEMAST handbook, <u>Living Things in Field and Classroom</u> (order from MINNEMAST)	4,7
4	signs reading "Girl," "Boy," "Right," and "Left"	5
1	* 12-ft. length of window sashcord, *rope or *yarn	6
30	* sets of 8 buttons	8
30	sheets of construction paper	8
30	boxes of crayons	8,10,13,18
1	* 100-ft. length of rope	10
1	penlight and bulb	11
2 each	batteries (1 live and 1 dead), magic markers (1 working and 1 worn out) and eggs (1 hard-boiled and 1 uncooked)	11
1	bowl or cup	11
30 each	* 1" x 2" strips of coarse, medium and fine sandpaper	12
4	* clear, plastic containers (tall, 12 oz.)	13,17
4	mustard paddles or teaspoons	13
8	* viscosity kits, or:	
	1 pt. each of corn syrup, mineral oil, vegetable oil, water	13
	36 glass marbles	
	32 large, clear plastic test tubes (vials)	
	32 screw caps or stoppers for test tubes (vials)	

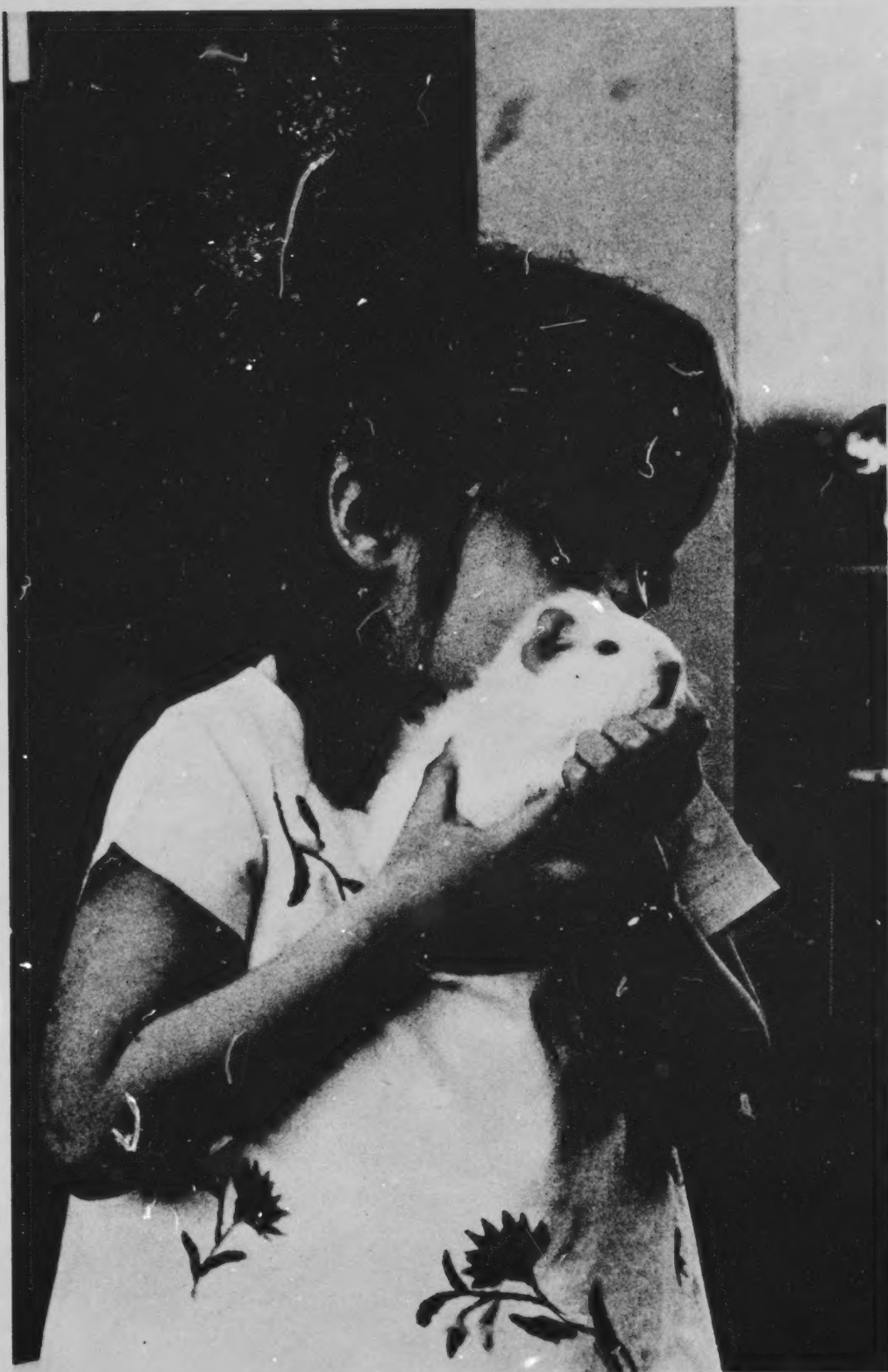
Unit 8 (cont.)

1	roll of paper toweling	14, 19, 20
6-8	large sheets of drawing paper	14
60	* small lumps of clay or plasticene, 30 of 1 color, 30 of another	15
30	* craft sticks	15
34	large sheets of newsprint	15, 17
12	* plastic containers (8-oz.)	16
12	ice cubes in a freezer tray	16
8 oz.	pasteurized non-homogenized (or raw) milk	17
1	roll of plastic wrap	17
2	rubber bands or 1 marking pencil	17
30	* paper trays	17
	glue	17
37	* balloons, 35 long, 2 short	18
37	paper clips; masking tape and several felt-tip pens	18
30	sheets of plain paper	18
35	** Letters to Parent from Teacher	
2-5	varieties of seeds, such as bean, beet, corn, okra, 19 pea, radish, grass (DISPO seed pouches, recom- mended on page III, are no longer made); morning glory seeds and narcissus bulb (optional)	
30	small transparent glasses, jars, or * 8-oz. plastic container	19, 20
50	mealworms	
1	transparent, plastic shoe box or wide-mouthed glass or jar of at least 1-qt. capacity	20
1	fresh apple or carrot	
1	package of enriched baby cereal, cornmeal, or dry bran cereal	20
1	small stone or block	
	outgrown and too large clothing	21
	baby, pictures of children (or others)	21

*kit items as well as

**printed materials available from
Minnemath Center, 720 Washington Ave. S.E., Mpls., Minn. 55455

***available from The Judy Company,
310 North Second Street, Minneapolis, Minnesota 55401



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INTRODUCTION

PURPOSE

- To provide practice in (1) observing and describing properties of objects, (2) sorting objects by their properties, (3) testing for properties, and (4) observing and measuring changing properties.
- To review fundamental mathematics concepts of sets and of the language of sets (set, subset, empty set); and to introduce the concepts of intersection and union of sets.

SUMMARY OF CONTENTS

This unit provides for the teaching of conceptual content and skills similar to those in the kindergarten units, Watching and Wondering and Describing and Classifying. However, there are two important differences:

- (1) the new contexts for the concepts and skills which the children already have had are presented at a somewhat faster pace; and
- (2) new ideas and skills are required. As in Watching and Wondering, the observation and description activities begin with looking at gross, familiar objects (the classroom, a desk) and proceed to more detailed observation of small objects (property blocks, leaves).

The children learn that characteristics or qualities of objects such as color, hardness, shape, or number of legs are called "properties." Therefore, descriptions of objects, as well as any discussion about the similarities or differences of objects, are in terms of properties. Children should be able not only to point to objects with given properties (a block with four corners) or with similarities or differences, but they should also be practicing communicating their perceptions as they observe and compare objects.

Communication skills are obviously important in working with others, but words have other important functions. Words are involved in the discovery of properties, for sometimes we do

not notice a property or a difference in properties until we have some related words. A child's association of words is basic to further development of his intellectual ability.

But the activities emphasize the properties of objects rather than the mere names of objects. A name can communicate only when it suggests a property with which we are already familiar. With the emphasis on properties, communication concerning an object can proceed even though the object may be unfamiliar to one or both participants. Properties other than the "use" property are also stressed, for the use of any object is really dependent on its other properties. Thus an attempt is made to move the child from definitions of objects based on their use (a chair is to sit on) to descriptions of more basic properties upon which "sitability" depends (such as the chair's shape, its height of seat from the floor, the ability of the material of which it is made to support one, etc.).

Careful observation of properties is important for effective problem-solving. Creative ideas are often the result of relating careful observations in two or more situations which were not previously related. Even solutions of very simple problems involve careful attention to properties. For example, we have a plant in the classroom, but no flower pot. What shall we do? The discussion invariably must deal with properties of the plant and of a flower pot. What properties of the plant make a flower pot necessary? What are the properties of the missing flower pot? What properties must a suitable container for the plant have?

Accurate observation of properties is also essential in classifying. Property names themselves denote classification schemes for objects. So, in this unit, while the child is learning classification words informally (and sometimes haphazardly), he is actively involved in the process of sorting or categorizing objects. This allows him to practice the method by which we arrive at classification schemes for a group of similar objects or events. In achieving order within any set of objects, events or data, we sort until we can simplify the situation. Then we look for relationships and generalizations. Obviously, then, sorting requires attention to properties of objects, since the sorting is based on some of

the objects' properties. An example of observing properties and sorting on the basis of such properties is the scheme of categories used to classify animals.

In Sections 1 and 2, in addition to the activities just described, the children begin to sort objects on a grid, so that they have constructed a histogram with the actual objects. This gives the children an opportunity to begin the development of skills with which they can deal with data, with the representations of data (x's or tally marks instead of objects), and with the concept of variation among similar objects. Variation is a concept necessary in the biological sciences, for within any biological category there are differences. The children are introduced to this idea in Lesson 7, when they observe how leaves vary in size, color, etc. Variation is also a necessary concept for measurement and statistics.

Section 3 focuses on testing for the existence of properties and for the reversibility or irreversibility of properties. Some properties are not immediately obvious, but are hidden until various tests are made. Also, some properties will remain unchanged in spite of various manipulations. Other properties will be changed by the manipulations. Of those that are changed, some can be changed back by reversing the action, but some cannot be. (A broken egg, for example, cannot be reconstructed to its original form.) Testing for reversibility or irreversibility necessitates careful description before and after the test, so that a comparison can be made. For this to be feasible, a reference object -- which has not been altered -- is kept, so that the children can make an effective before-after comparison with the altered object. In this section, the children are also asked to order objects according to some property and to arrange them in a series from small to large and from low to high. Producing changes in properties experimentally and noting changes under varied conditions are important processes in problem-solving in many fields. The children receive some practice in both of these processes, as well as in predicting -- and testing for -- changing properties.

The last three lessons of the unit, which comprise Section 4, accent the fact that the identity of a biological object (plant, animal, human) continues despite many changes in external form. The retention of biological identity is a rather sophisticated idea. You will find it interesting to note that, although a child readily accepts the continuing identity of the mealworm -- whatever its outward changes -- he finds it extremely difficult to imagine himself as being, or ever having been, the little person he sees in his baby picture.

NOTES ON TEACHING THIS UNIT

This is the first unit for first grade. Its position relative to other units in kindergarten and first grade is shown on the page inside the front cover. The unit has four sections, each of which emphasizes a particular topic. The sections are divided into lessons, most planned to take about one class period. It is expected that generally two periods a day will be used for MINNEMAST material. You may choose to teach this unit until it is completed or you may start Unit 9 at any time after Section 2 is done and teach the two simultaneously. If taught alone, Unit 8 takes four to five weeks.

An effort has been made to begin a first grade program that is not crucially dependent on kindergarten or on previous use of MINNEMAST materials; but, if you think it necessary for your class, select lessons or activities from Describing and Classifying (Unit 3) and from Using Our Senses (Unit 4) and conduct these. Because first grade children are much more mentally advanced than those in kindergarten, they need not do any of the lessons in Units 1 or 2. However, the attitudes begun in the MINNEMAST kindergarten materials are very important and should be kept in mind while teaching all units.

Each section begins with a brief discussion of its content. Lessons include more detailed comments on the ideas involved. Each lesson has a list of the materials needed and suggestions for carrying out the activities. Important questions are capitalized and children's probable reactions are set off in parentheses. The questions are intended to serve only as guides to help you in planning the lesson and need not be used verbatim.

DEFINITIONS

Sets

Sorting or classifying objects according to their properties involves separating them into groups which are known mathematically as "sets." Set concepts are important in the operations of mathematics and science and are basic to studies of logic and probability, yet they can be put in contexts that are simple enough to be used by a child. The mathematical ideas introduced here will be continued in other first grade units.

There are two ways to define a set. One way is by listing its members. But we focus on the other, more important way, in this unit. The sets or subsets are here defined as meaning those with one (or more) properties or characteristics common to all members of the defined set. A defining property gives us a way to tell which objects are, and which objects are not, members of our defined set. Every object which has the property is a member, and every object which does not have the property is not a member of the set. Every object which has green coloring is a member of the set of green objects and only green objects are members. The property of greenness is the defining characteristic of the set.

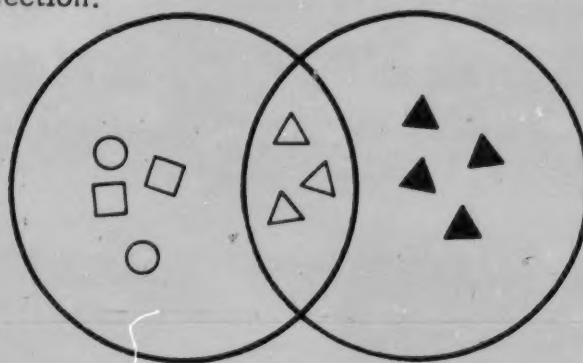
Subset

A subset of a set is any selection of the members of that set. For example: the set B is a subset of set A if -- and only if -- every member of set B is also a member of set A. To be more specific: if all the crayons in the classroom are represented by A, and all the purple crayons represented by B, the subset B is the set of all purple crayons in the classroom. Set A contains not only B, but also red crayons, yellow crayons, etc. The list of subsets of set A includes the entire set A and the empty set -- the set which has no members.

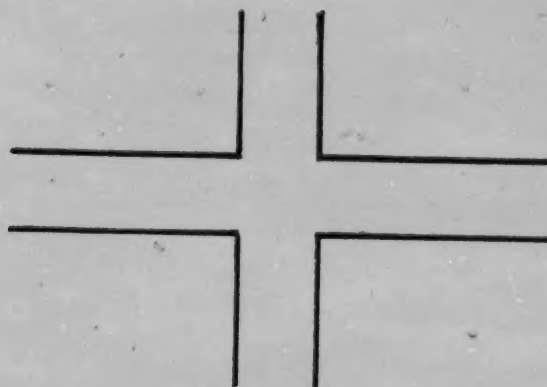
Union And Intersection

Two mathematical concepts which were not covered in kindergarten are union and intersection. "Union" refers to the situation where two sets are put together (red blocks and green blocks pushed together) so that the combined set is characterized by red or green blocks.

In the situation where objects or areas are being classified, intersection refers to the objects or areas which are described by the combined properties or classifications of two or more sets. Hence, if we are sorting white objects and triangular objects, the white triangular objects are in the intersection.



Similarly, a street intersection is that part of each street which is part of the other street.



SECTION I | OBSERVING AND DESCRIBING PROPERTIES

PURPOSE

- To provide opportunities for careful observation and description of properties of objects.

COMMENTARY

Early in the school year, there are many opportunities -- both indoors and out -- for children to observe and describe. For the new first grader, observing and describing involve examining an object closely and identifying its properties. These properties include characteristics -- such as color, size, and shape -- that can be determined visually (often because of previous experiences), and others -- such as texture, aroma, sound, and taste -- that must be determined by using senses other than sight.

An important goal of this section is the communication of perception through the description of properties. There are two ways for children to show that they perceive properties:

(1) the verbal way. The child attaches appropriate words to an object: "This block has the properties of redness and square shape."

(2) the operational way. The evidence of the child's perception is shown by the sorting of all the blocks that have the properties of redness and square shape.

Operational descriptions are important for several reasons:

(1) When a child can perform an operation of sorting, you have more knowledge of what he is responding to, and are therefore in a better position to make any necessary clarification or extensions.

(2) Children can transfer the process of grouping objects into sets and subsets to a variety of situations. Also, after grouping objects, children can recognize similarities and differences more clearly.

(3) The active sorting operation provides experience relevant to mathematical concepts: a collection of objects to be observed and described is a set, and members of that set, having one or more similar properties, form subsets.

Observation and description begin with large objects in the classroom in Lessons 1 and 2, and continue in Lessons 3 and 4 where properties of rather small objects (blocks, animals, etc.) are examined.

NOTE

Send a copy of Dr. Werntz's letter home with each child as soon as work with the unit begins.

Office of the Director

Dear Parent:

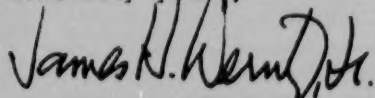
Your child will participate in an experimental program in learning during this school year. The curriculum was developed by MINNEMAST, the Minnesota Mathematics and Science Teaching Project. Mathematics and science are introduced to your first grade child in a single coordinated treatment that is relevant to his everyday life. Teams of educators, teachers, mathematicians, and psychologists -- working together -- developed the method and materials of the program. Schools use the program only with direct supervision of qualified consultants from a neighboring university.

We live in a world that is changing rapidly -- more rapidly than ever before in history. This means that we cannot predict accurately what a child will need to know in later life. The aim of MINNEMAST is to prepare the child to solve problems for which there can be no specific instructions now. The MINNEMAST curriculum provides many experiences in observing, describing, measuring and experimenting. In this way, the child develops attitudes and skills which equip him for lifelong learning. We have reason to believe that the child retains what he learns through his own efforts and that he enjoys the process of discovering for himself.

The first unit in first grade is Observing Properties. It is intended to encourage your child to explore his surroundings and to help him observe and describe properties of some of the things he finds. He classifies objects into sets according to their properties, and he does some simple experiments to discover more about these properties.

You are invited to share in your child's activities. For example, when his class is asked to observe size changes with growth, we suggest that you have him try on his outgrown clothing and clothing of an older person in the family. Your child will tell you of other experiences you can share. We will inform you occasionally about the experimental materials and the kind of instruction your child is receiving. We hope you will find this information helpful. Your comments and reactions can be valuable to us.

Sincerely yours,



James H. Werntz, Jr.
Associate Professor of Physics
Project Director

Lesson 1: EXPLORING FIRST GRADE

COMMENTARY

There are many objects in the first grade room which are new and exciting to the children, and the children should be given time to explore them. There are also new activities, such as recess and (maybe) the lunch program, with which children need to become familiar. Helping them get acquainted with their new surroundings is a necessary part of the activities of the first few days, and this serves nicely as the means of beginning lessons in observation. Please feel free to adapt the suggested activities of this lesson to your special situation, but -- in any situation -- you will want to encourage the children to explore, and to continue exploring at various times throughout the year, whenever it is opportune.

PROCEDURE

Activity A

The children in your room may or may not have had kindergarten; but at some time during one of the first class sessions, ask whichever of these questions is suitable to your group:

DOES THIS ROOM LOOK LIKE YOUR KINDERGARTEN ROOM? LIKE YOUR NURSERY SCHOOL ROOM? LIKE YOUR SABBATH OR SUNDAY SCHOOL ROOM? LIKE YOUR LIVING ROOM AT HOME?

As the children mention various objects which they did not have in kindergarten, in other schools, or at home, list them on the board. Then suggest that they walk about the room to see whether they can discover other interesting objects.

In a few minutes, ask them to sit down. Then, either verbally or on the board, add their new contributions to the list of objects. Discontinue the activity whenever you see fit, but keep it in mind so that you can return to it later in the day or on other days.

You might ask the children to help you make up a story about their new room. This could become the start of a continuing

record of their experiences in first grade. It could also provide material appropriate for their first reading lessons.

Activity B

Suggest to the children that there are activities which they do in first grade that they did not do last year.

DOES ANYONE KNOW OF SOMETHING WE DO IN
FIRST GRADE THAT WE DIDN'T DO IN KINDERGARTEN?
If they haven't had kindergarten, the question will
need to be re-phrased: THAT IS THE SAME AS ALL
THE OLDER CHILDREN DO?

If no one answers:

IN A FEW MINUTES WE WILL BE GOING OUTSIDE
TO PLAY. WHO KNOWS WHAT WE CALL THAT?
(Recess.)

If there are rules about recess, this is a good time to talk about them; and if there is a certain place where they are to play, this can be discussed, too.

If there is a school lunch program, this also should be discussed. You will probably take the children to the lunch room before their scheduled lunch period. Before you leave the classroom, ask the children to be alert for the differences between the classroom and the lunch room and for any particularly interesting things they may see. When you return to the classroom, have them discuss what they have noticed.

Activity C GAME: IDENTIFY THE OBJECT

This game is somewhat similar to "20 Questions," though there is no limit to the number of questions that may be asked. Have groups of two or three children get together where you and the rest of the class cannot hear them. Ask a group to select some object in the room as their secret object. They are not to tell you or the rest of the class what object they have chosen. You try to identify the object selected by asking these children questions that can be answered by yes or no, and when you have enough information to identify it, you say what it might be.

Sometimes use comparing questions such as, "Is your object as heavy as a book?" or "Is your object the same color as Billy's shirt?" Encourage the children to ask questions also.

Activity D EXPLORING OTHER AREAS

Choose an unfamiliar room or other area, in or near the school, for exploration. In this illustrative lesson, the gymnasium is selected, as it offers many new and exciting experiences. But the lunchroom, library, music room, or playground would also be interesting.

Having to change to tennis shoes before going to the gym will be a new school experience for first graders. Ask the children to describe the properties of tennis shoes and their differences from regular shoes and to discuss why they are required to wear these special shoes in the gym.

When going to the gym, ask the children to notice in what ways the gym is different from their first grade room. They will probably mention its size.

IN WHAT WAYS IS THE GYM DIFFERENT FROM
OUR ROOM?

HOW DO YOU KNOW IT IS LARGER?

HOW COULD WE FIND OUT?

After you hear the children's answers, suggest that all hold hands and stretch out to see how long the gym is. Repeat this in the classroom, when you return to it, and allow them to determine from the results whether the gym is longer.

Then encourage them to explore the gym. They will find new equipment that they have not seen before, even if they were in the gym during their kindergarten year. If there is equipment which first graders should not use, tell them about it before they start exploring.

When you are back in the classroom, continue the discussion of ways in which the gym differs from the classroom. Have them discuss other differences besides length and relative size.

Have the children make up riddles about some of the equipment or materials they saw in the gym. Start them off with some property descriptions (riddles) such as:

IT IS LONG AND THIN.

IT IS TWISTED.

WE CAN SWING ON IT.

WE CAN CLIMB IT.

IT HANGS FROM THE CEILING.

WHAT IS IT? (A rope.)

Lesson 2: PROPERTIES OF A DESK

COMMENTARY

When the children were talking about their room, one of the pieces of furniture they probably mentioned was a desk. In this lesson they investigate and describe the properties of a desk. Some children will know what properties are and will be able to describe their desks easily. Others will need help at first. Since classrooms differ somewhat in their furnishings, the outline of the lesson is only suggestive.

PROCEDURE

Activity A

WHEN WE TALKED ABOUT OUR ROOM THE OTHER DAY, WE MENTIONED OUR DESKS AS SOMETHING NEW. TODAY LET'S TALK ABOUT THEM.

EACH OF YOU HAS A DESK. IT IS YOUR OWN WHILE YOU ARE IN THIS ROOM.

WHAT CAN YOU TELL ME ABOUT YOUR DESK?

WHAT ARE SOME OF ITS PROPERTIES?

MAYBE FIRST WE SHOULD MAKE SURE WE KNOW WHAT "PROPERTIES" ARE.

Have the children tell you. If they can't, suggest several, such as: color, shape, smoothness, use.

Choose a child who seems to understand what you want and ask:

TELL ME ONE THING ABOUT YOUR DESK. I WILL WRITE IT ON THE BOARD.

Have other children tell you different things about their desks. The chairs or seats may also be included.

If the children are not responding easily, ask some of the following questions:

WHAT COLOR IS YOUR DESK?

OUT OF WHAT IS IT MADE?

IS IT FASTENED TO THE FLOOR?

DOES IT HAVE LEGS? HOW MANY?

CAN YOU OPEN IT?

HOW IS IT PUT TOGETHER?

WHAT'S INSIDE IT?

Perhaps the children would like to make up a story as though the desk were telling it. The children will be able to think of many different things for the desk to say. And, as shown in the following example, they may tell the story about the desk in either the first or third person:

I AM PETER'S DESK -- or -- THIS IS PETER'S DESK.

I HAVE FOUR LEGS -- or -- IT HAS FOUR LEGS. Etc.

MY TOP IS SMOOTH AND HARD.

I HAVE A POCKET.

THERE ARE ALL KINDS OF THINGS IN MY POCKET --
BOOKS, PAPER, CRAYONS, SCISSORS, PASTE.

SOME PEOPLE HAVE PUT WET TOWELS IN ME. SOME
HAVE EVEN PUT PART OF THEIR LUNCH IN MY POCKET.
WHEN THE FOOD SPOILS, IT MAKES ME SMELL FUNNY,
AND I DON'T LIKE THAT AT ALL.

SOME PEOPLE PUT TOO MANY THINGS IN ME, SO
THAT MY TOP WON'T GO DOWN. I DON'T LIKE
THAT, EITHER.

I THINK PETER WILL KEEP ME NEAT AND CLEAN.

Activity B

WE TALKED ABOUT THE PROPERTIES OUR DESKS HAVE, AND WE DESCRIBED THEM VERY WELL. FROM YOUR DESCRIPTIONS, IT SEEMED TO ME THAT ALL YOUR DESKS WERE QUITE SIMILAR. HOW DO YOU KNOW WHICH DESK IS YOURS?

THAT'S RIGHT, YOUR DESK IS IN A CERTAIN PLACE IN THE ROOM. HOW CAN YOU TELL ME WHERE IT IS?

Pause for answers, then:

YES, YOU CAN TELL WHERE YOUR DESK IS BY THE ROW IT IS IN. AND YOU CAN TELL BY WHETHER IT IS NEAR THE WINDOW OR THE CHALKBOARD. AND, YES, BY WHO SITS IN FRONT OF YOU, OR WHO SITS IN BACK.

When the children have pretty well exhausted identifying the location, you may want to devise a game for them or, if you think it will interest them more, use "Simon Says." With all children starting from a sitting position for each instruction, the game would go something like this:

ALL CHILDREN WITH DESKS BY THE WINDOW,
STAND UP.

ALL CHILDREN WITH DESKS BY THE WALL, CLAP
HANDS.

ALL CHILDREN WITH DESKS ON THIS SIDE, RAISE
THEIR HANDS.

ALL CHILDREN WITH DESKS BEHIND THEM, PUT
THEIR HANDS ON THEIR HEADS.

THE CHILD WITH THE DESK NEAREST THE DOOR,
STAND UP.

THE CHILDREN WITH NO DESKS IN FRONT OF
THEIRS, RAISE THEIR HANDS.

THE CHILDREN WITH NO DESKS IN BACK OF
THEIRS, RAISE THEIR HANDS.

Lesson 3: PROPERTIES OF BLOCKS AND OTHER OBJECTS

COMMENTARY

In this lesson children use smaller objects than in Lessons 1 and 2, and observe and describe them in greater detail. Properties which are apparent from just looking are size, thickness, color and shape; children are very dependent upon vision for recognizing properties -- even those properties which must be verified by touch. While they may be able to label certain visual patterns (a triangular-shaped block, for example), detection by touch provides additional sensory data. Properties that may be missed visually and that may be more easily recognized by touch are, among others, the number of corners, number of surfaces, and shapes of the surfaces of a block. This is the reason that activities in this lesson involve not only properties which are sensed visually, but also activities where touch provides the observation for property description. You ask the children first to respond to instructions involving one property and later to instructions for two properties. You also give some attention to instruction about what properties an object does not have. The properties possessed and not possessed by an object are important for later sorting exercises, as well as for developing communication skills.

MATERIALS

- property blocks. You will need 8 of each shape -- some thick, some thin, some wrapped individually in soft paper or opaque plastic bags.
- "fingertip properties" kit. If you have no kit, prepare 7 or 8 sets of objects that possess interesting properties detectable by touch. Include 10 different objects from the following list in each set (or substitute similar ones).

silk cloth	rubber eraser	soap
wool cloth	wood block	tree bark
sandpaper	tin foil	adhesive tape
writing paper	stone	metal object
steel wool	half potato	waxed paper
viscose sponge	lump of coal	burlap
deflated balloon	cotton	tissue

PROCEDURE

Activity A

Because this is the first time in first grade that children use property blocks, allow them some free play with the blocks. Then put all the blocks away. Holding one set in a box or bag, have the children ask you for certain blocks, one at a time, by describing them. Begin by showing one block and saying that there is no other one exactly like it in the bag, but that there are others of other shapes, colors, sizes and thicknesses.

Activity B

Arrange the children in groups of three or four and have each group sit in a designated place on the floor. (You may find it helpful to push the desks aside to provide a larger working area for this.) Now distribute some blocks to each group. The groups need not each have the complete set or identical blocks, unless you so wish. Keep some blocks for yourself. Select a block from your supply, hold it up, and ask the groups:

FIND ANOTHER BLOCK OF THE SAME COLOR AS MY BLOCK.

FIND ANOTHER BLOCK OF THE SAME SHAPE.

Repeat this, holding up other blocks. Then:

FIND A BLOCK THAT IS RED.

FIND A BLOCK THAT IS SQUARE-SHAPED.

Continue with instructions for other properties:

FIND A BLOCK WITH CORNERS.

FIND A BLOCK WITH NO CORNERS.

Now select one of the wrapped blocks. Have the children feel it through the wrapping. Then instruct:

PICK A BLOCK FROM YOUR SET THAT FEELS LIKE THIS BLOCK.

Repeat the instruction, using other wrapped blocks.

Activity C

Again arrange the children in small groups and give each group some property blocks. Repeat the types of instructions you used in Activity A. After asking the children to match your block with another of the same color, shape, etc., add requests for blocks of similar size or thickness -- when you think the children are ready.

After giving a number of instructions for finding blocks with one property (shape, color, etc., as in Activity A), ask for blocks with two properties. Use instructions such as these:

FIND A BLOCK THAT IS RED AND SMALLER THAN THIS ONE.

FIND A BLOCK THAT IS THICKER AND LARGER THAN THIS BLOCK.

Repeat with other combinations of two properties.

Now hold up a block and ask the children to tell you what that block is not. For example, a red, small, thick, triangular-shaped block is not blue, not yellow, not thin, not square-shaped, etc.

Give various children turns at holding up a block, so that the rest of the class can tell them what it is not.

Activity D

Place each set of objects from "fingertip properties" kit in a shallow cardboard box or on a cafeteria tray. Arrange the children in groups of three or four and have each group sit in a designated place on the floor. Distribute one tray to each group and ask the children to examine all the objects carefully. They should look at them, turn them over, touch them, squeeze them, bend them, etc. While the children are examining the objects, you might circulate among the groups to ask leading questions about the properties of the objects.

Call for volunteers to describe the objects, one at a time. Have several children contribute to each description. If they disagree over properties, ask them to re-examine the object.

After these descriptions:

NOW WE ARE GOING TO PLAY A GAME. I WILL THINK OF AN OBJECT. YOU WILL TRY TO DECIDE WHICH OBJECT I AM THINKING ABOUT. I WILL HELP YOU BY NAMING PROPERTIES OF THE OBJECT, AND YOU CAN LOOK AT YOUR OBJECTS TO SEE WHICH OBJECT I HAVE IN MIND.

Name one property at a time, avoiding the object's function property. As you name each property, have the children in each group take turns putting aside the subset of objects which seem to have that property.

Example:

THE OBJECT I AM THINKING OF IS ROUGH AND SCRATCHY. The children might set aside the sandpaper, steel wool, lump of coal and tree bark.

LOOK AT YOUR SUBSET OF ROUGH AND SCRATCHY OBJECTS. THE OBJECT I AM THINKING OF IS ALSO VERY FLAT AND THIN. TAKE OUT ANY OBJECTS THAT ARE FLAT AND THIN, AND PUT BACK THE REST. They might now keep a subset of only the sandpaper and tree bark.

IT IS MUCH SMOOTHER ON ONE SIDE THAN ON THE OTHER.

If they still cannot decide:

ONE SIDE HAS LITTLE GRAINS OF SAND ON IT.

An example of another property with which to begin is, "I can squeeze it together in my hand."

In all instances, after giving a property that includes a number of objects, proceed with more specific properties that the particular object has: "I can stretch it," or "It is heavier than most of the other objects."

Activity E GAME: IDENTIFY THE OBJECT

Use the same sets of objects here as in Activity D, but keep one set aside. Distribute the other sets among small groups of children. Have two or three children get together where you and the rest of the class cannot hear them and select among themselves an object from the tray as their secret object. They must not tell you or the rest of the class what object they have chosen. You and the class try to identify the object by asking questions that can be answered with yes or no.

Lesson 4: PROPERTIES OF SMALL ANIMALS

COMMENTARY

In preceding lessons children identified and grouped objects according to their shapes, colors and textures. This gave them practice in using different senses to determine properties. Here children observe small animals and consider more complex properties (sizes, appendages, body forms) as well as behavioral patterns (eating, sleeping, moving, etc.).

The experience of collecting and maintaining animals for classroom lessons is valuable to the children. It calls for responsible and careful handling of forms of life; and children find both the animals and their care fascinating.

Three activities are described for this lesson. The first is the collecting of the small animals; the second involves observations of their forms and behavior over several days; and the third directs children to group the animals into subsets according to each of several properties. This last experience is intended to emphasize similarities and differences among the animals.

The primary purposes are to give the children opportunities to see some of the seemingly infinite varieties of animals and to discern their differences and similarities. Careful observation of the basic properties of living things is an important technique to develop. It is also a means to appreciation and enjoyment of the biological world. Although we want the children to observe the living animals very closely, they need to be told (and probably reminded from time to time) that very careful handling of living things is necessary.

Consult the MINNEMAST handbook, Living Things in Field and Classroom, for directions about where to look for small animals and how to collect and maintain them. The schoolyard and adjacent areas along sidewalks may provide enough material for the activities of this lesson. Plan to do the collecting at any convenient time before the first frosts, because these eliminate many insects. Also plan your collecting for periods near noon, when more animals are about.

It would be very desirable if you could conduct all the activities of this lesson during one day. All of the small animals may not survive for future study; however, if they are properly maintained, many can be added to the classroom "zoo" when the lesson is completed.

It is important that this lesson be done with living things. Do not substitute films or stories for these first-hand experiences.

MATERIALS

- small animals collected and brought back to class
- plastic bags, with fasteners, for collecting
- magnifying lenses
- MINNEMAST handbook, Living Things in Field and Classroom, for information on maintaining the collected specimens.
- "Grandpa Dunn" -- Story
- pictures of animals and plants
(Worksheets 1, 2, 3, and 4 of Student Manual A)

PROCEDURE

Activity A COLLECTING SMALL ANIMALS

Read the following story about Grandpa Dunn at some time shortly prior to taking the children outdoors on a collecting trip.

GRANDPA DUNN

Steven, Stanley and Elizabeth had a neighbor they called "Grandpa Dunn." One day while they were admiring Grandpa Dunn's garden, Stanley asked, "Grandpa, could you tell us where to find little animals? We've been collecting some from our garden. Could we find them in other places, too?"

"A garden's a good place to find little animals," Grandpa Dunn said. "Have you looked in the ears of corn and at the bottom of the stalks? You can find many little animals by digging around the bottoms of plants."

"We've done that," Elizabeth said, "and we've found some, but we thought maybe there were other places to look."

"There are," Grandpa Dunn said. "When I was a boy, I found little animals under rocks and stones, and in the bark of trees, and under piles of old leaves. I even used to see some on the sidewalks, and around pipes, and in the corners of the basement. Basements have many kinds of little animals. Sometimes you can find animals fluttering around lights at night, too, or on window sills, or the bottoms of leaves."

"Thank you, Grandpa Dunn," the children said as they started to run away.

"Just a minute!" the old man said, and the children stopped. "I want to warn you not to go picking up every little animal you see with your bare hands, because some of them bite."

"I know," Stanley said, pointing to a lump on his arm. "That's a mosquito bite. It itches."

"Flies sometimes bite, too. And bees can sting, so be careful," Grandpa Dunn said.

"We will," Steven said. "When we see a little animal, we'll plop an ice cream carton over him. Then we'll slide a piece of paper where the top of the carton is and press the paper down around the top, and finish up by keeping the paper in place with a rubber band."

"That's the best way," Grandpa Dunn said. "But if you want to look closely at a little animal, its better to put it in a clear plastic jar later. If you have any trouble getting your animal from your cartons into your jars, bring them here and I'll help you."

"How will you do that?" Elizabeth asked.

"I'm not sure how I'll do it," Grandpa Dunn said, "but I expect if I gave a carton a little thump, I could slide an animal into a jar while it was still too surprised to know what was going on. Or maybe I could make a hole just the right size in the cover of the carton and then turn it upside down over the jar. I would want to be careful not to hurt the animal, though. I'll be thinking about ways to do it while you're all out collecting."

"We each have a carton and we'll come back as soon as we've each found one animal, Grandpa Dunn," Steven said. The children scampered off to start the small-animal hunt.

They hunted under stones, under piles of dead leaves, and under leaves that were growing on bushes. They examined the sidewalks and the cracks in the sidewalks. Very soon each child had an animal in an ice cream carton. They hurried back to Grandpa Dunn.

"Oh, what a fine start -- a cricket, a spider, and a beetle!" Grandpa Dunn exclaimed. He put the little animals into transparent plastic jars, covered the cups with clear plastic paper, and snapped rubber bands around the covers. "Now how about a search in the basement?" he said, and the children scampered away again.

Finis

Take the children to the playground, an empty lot, or the grass strip between a curb and a sidewalk. Sidewalk cracks, puddles, ponds, old logs and grassy fields are also dwelling places for innumerable small animals. The children will probably find earthworms, garden snails and slugs, small beetles, pill bugs, winged insects, caterpillars and garden spiders. These smaller animals can be collected in the plastic bags and returned to the classroom. Other animals, such as birds, dogs, squirrels, etc., should also be observed for later description and discussion.

Before leaving the classroom, tell the children to look for as many animals as they can find in the area. Remind them to be quiet -- as though they were stalking -- so that animals will not run away from the noise and confusion. You might like to assign some children to watch the sky for birds, some to look for flying insects and some to search in trees and bushes. Others could concentrate on the ground and look under sticks, leaves, and rocks for the little animals.

Ask the children to indicate quietly when they find something to be collected in a bag (ant, grasshopper, snail, etc.) or when they have found something that all should observe (dog, bird, cat), so that they can collect this, too, in their memories. If children collect caterpillars, they should bring along part of the plants upon which they find them, as caterpillars will not feed on any substance except that which they have been eating. If caterpillars are full grown when found, they are likely to be more successful both at spinning a cocoon and at completing metamorphosis. You may wish to take charge of the actual collecting yourself, but you could assign this job to several non-squeamish, careful, dexterous children.

If Activity B is not done on the same day as the collecting, house the animals as the handbook directs. (After Activity B, keep any animals wanted for the classroom zoo and release the others.)

If the animals have been collected separately (all ants in one bag, all earthworms in one, etc.), they can be examined while still inside the bags.

Activity B OBSERVING THE ANIMALS

Put the collected animals in containers and places where all children can observe them. A great variety of animals is not really needed here -- a collection which includes earthworms, ants, grasshoppers, butterflies and spiders would be quite a satisfactory assortment. Give the children plenty of time to observe the locomotion and body parts of all specimens. They will find hand lenses (magnifying glasses) very helpful to their observation, and you will find the MINNEMAST handbook helpful in providing appropriate questions to ask about each animal.

Activity C MAKING SETS OF ANIMALS ACCORDING TO THEIR PROPERTIES

Begin the activity by asking the children to sort the animals into sets by the number of legs they have. Simple sketches or names of the animals can be put on the board, because you will also want to add the names of some of the animals that were observed, but not collected. Ask helpful questions appropriate to both the collected and the remembered animals.

WHICH ANIMALS HAVE EIGHT LEGS? (Spiders.)

WHICH ANIMALS HAVE SIX LEGS? (Ants, butterflies.)

WHICH ANIMALS HAVE FOUR LEGS? (Dogs, cats, squirrels.)

WHICH ANIMALS HAVE TWO LEGS? (Birds.)

At this point remind the children that there are other two-legged animals present. It will amuse them to classify themselves.

ARE THERE ANY ANIMALS WITH NO LEGS?
(Earthworms, snails.)

ARE THERE ANY ANIMALS WITH MORE THAN EIGHT LEGS? (Centipedes, sow bugs.)

The children may have to look at the animals more than once to make sure of their answers.

WHAT OTHER SETS CAN WE MAKE? (We can make sets of animals by their color; by their covering -- which may be hard, soft, furry, feathery, etc; by their special body parts -- such as eyes, antennae, divisions into segments; and by the way they move -- crawl, walk, fly, hop, etc.)

Activity D

The children use Worksheets 1-4 of Student Manual A here. These are pictures of plants and animals which they are to cut apart carefully on the straight lines of each sheet. After they have cut the pictures apart, tell the children to sort all the pictures into two subsets in any way they wish. Ask them to tell by what property they made the two subsets.

Next have the children put away the subset of plant pictures. Tell them they are now going to make subsets of animal pictures. Review some of the properties of animals they discussed in Activity C, and ask them to think of any more properties they could use to make subsets of animals. Now, using whatever property they choose, have them make two subsets of the pictures. If the property a child uses is not obvious, ask him what property he used to make his subsets. He may say, "These animals have wings and these don't," etc. If he cannot explain verbally, have him point to the property in the pictures.

Now have the children make subsets of the plant pictures. They could do this freely at first, discovering properties for sorting by themselves. But if they are having difficulty, ask the whole class to participate in making up a list of some of the various properties of plants they might use for making subsets. You could add to this list, too, naming such properties as number of petals, number of leaves, shape of leaves, shape of flowers, etc.

When they have had a good deal of experience in sorting the pictures, have each set put in a bag or envelope and save them for use in Lessons 8 and 11.

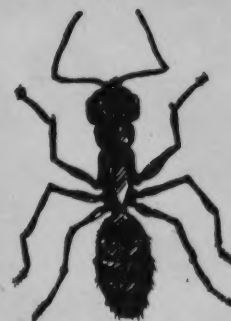
NAMES OF PLANTS AND ANIMALS ON WORKSHEETS 1-4

White Trillium	1
Wild Rose	2
Worker Ant	3
Dragon Fly	4
Earthworm	5
Snail	6
House Fly	7
Water Sow Bug	8
House Spider	9
Geranium	10
Blooming Potato Plant	11
Yellow Wood Sorrel	12
Spiderwort	13
Blooming Cotton Plant	14
Corn Cockle	15
Wild Strawberry	16
White Campion	17
Flowering Raspberry	18
Ring-necked Snake	19
Acadian Flycatcher	20
Gekko	21
Red Bat	22
Crappie	23
Green Frog	24
Rooster	25
Turtle	26
Redhead Duck	27
Monarch Butterfly	28
Fur Seal	29
Fox Terrier	30
Beaver	31
Mosquito	32
Ladybug	33
Millepede	34
Grasshopper	35
Albatross	36

Worksheet 1
Unit 8



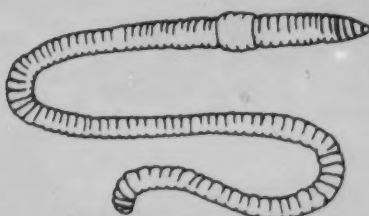
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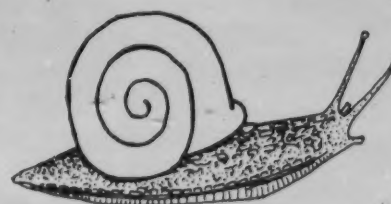
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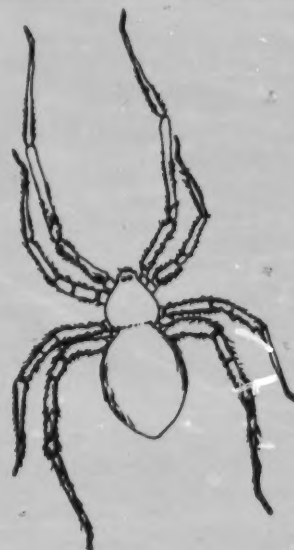
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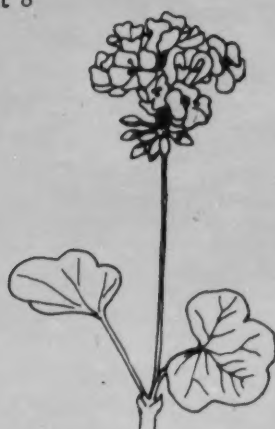


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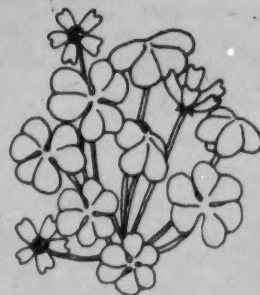
Worksheet 2
Unit 8



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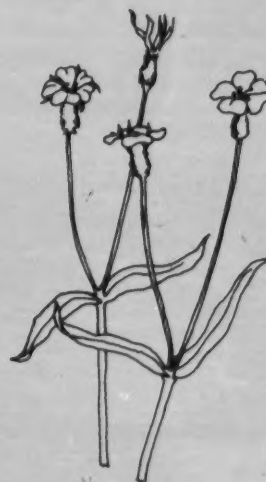
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Worksheet 3
Unit 8



19



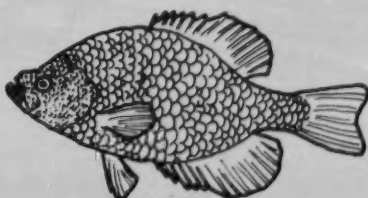
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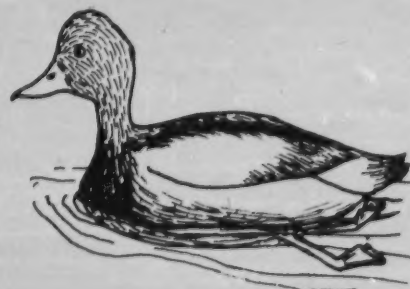
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Worksheet 4
Unit 8



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SECTION 2 SORTING SETS BY PROPERTIES

In Lessons 5, 6, and 7 children sort objects, including themselves, into sets and subsets according to two properties and they learn to use simple grids. In Lesson 8 they have some experience with the concepts of intersection and union. Lessons 9 and 10 require sorting into subsets according to three properties, and also introduce the idea of a tree diagram. A story, "A Trip Up The River," presents the concept of a tree diagram first, in Lesson 9. Then in Lesson 10, children have some physical activity to reinforce the idea. The focus of this section is on experience with properties as they are used to define sets and with set terminology: set, subset, empty set, intersection and union.



Lesson 5: SORTING THE CLASS INTO SUBSETS BY TWO PROPERTIES

COMMENTARY

The children themselves are the set of objects in this lesson. For two of the subsets, the children are asked to say which property has been used. For the other two subsets they are told the property and asked to sort themselves. By standing in different corners of the room, the children sort themselves according to the different properties -- sex and handedness (left or right) -- into the four subsets. The new words that you should use frequently and in the proper contexts are "set," "subset," and "empty set."

MATERIALS

- 4 large sheets of paper reading "Girl," "Boy," "Right," and "Left," respectively

PROCEDURE

Ask everyone in the set of children in the room to stand. Tell them that you are going to sort them into two subsets -- one in the front of the room and one in the back -- and they are to say what property you used. Name the children, one by one. After each girl, say "front;" and after each boy, say "back." When the children have correctly stated the property by which they were arranged, ask them to move to the appropriate part of the room. Ask each subset which sign is the right one for them and have them set it up near themselves.

Now, on one side of the room place the large piece of paper that says, "Right." Place the sign saying "left" on the opposite side of the room. Then ask the children how they could make subsets of left-handers who are girls, and left-handers who are boys, right-handers who are girls, and right-handers who are boys. Show them the signs if they need to be reminded. Ask them to move so that there will be four subsets and so that the signs will correctly describe them.

While the children remain at these four places, ask questions such as:

WHERE IS THE SET OF CHILDREN?

WHERE IS THE SUBSET OF ALL LEFT-HANDED CHILDREN?

WHERE IS THE SUBSET OF ALL RIGHT-HANDED CHILDREN?

WHERE IS THE SUBSET OF ALL GIRLS?

WHERE IS THE SUBSET OF ALL BOYS?

WHERE IS THE SUBSET OF ALL LEFT-HANDED CHILDREN WHO ARE GIRLS?

WHERE IS THE SUBSET OF ALL RIGHT-HANDED CHILDREN WHO ARE GIRLS?

WHERE IS THE SUBSET OF ALL LEFT-HANDED CHILDREN WHO ARE BOYS?

WHERE IS THE SUBSET OF ALL RIGHT-HANDED CHILDREN WHO ARE BOYS?

WHERE IS THE SUBSET OF GIRLS WITH BLUE HAIR? (The empty set.)

WHERE IS THE SUBSET OF BOYS WITH FOUR ARMS? (The empty set.) Etc.

Lesson 6: SORTING PROPERTY BLOCKS

COMMENTARY

Subsets of property blocks are given to the children. The children briefly review the properties of the blocks and form subsets, according to the properties they have described, by placing blocks inside two large closed curves on the floor. Such sorting is clearcut because only one property defines a set. For instance, one curve may be defined as containing a subset of blocks that are red (it contains blocks of no other color). The other curve would contain only blocks that are not red. In another example one curve may specify a particular shape and would include only triangular-shaped blocks. The other curve would contain only blocks that were not triangular-shaped.

But in Activity C, the closed curves define subsets for two different types of properties and a block must be placed according to both. So, if one closed curve is to contain blocks with the property of redness, and the other closed curve is to contain those with triangular shape, then the child who tries to place a block that is both red and triangular has a challenge. He knows that the block belongs in both subsets and now is given the problem of trying to arrange the curves so that the block can be included in both. In this activity, allow children plenty of time to recognize the problem and to discover the solution of overlapping the curves. The area of overlap is called the "intersection." The red triangular block goes into the intersection.

Activity D involves copying a pattern, making a change in one property at a time, i. e., a transformation. This is an introduction to activities which develop the concepts of mathematical transformations and mathematical groups.

In the various activities -- when the subsets are pushed together in preparation for the next sorting, use the word "union." In sorting blocks after the activities, the children are introduced to the procedure of constructing histograms, a method they will use in Lesson 7.

The activities of this lesson should also be done by children themselves and/or be made available for free play.

MATERIALS

- several sets of property blocks
- 2 six-foot lengths of window sashcord, each taped neatly into a large closed curve (or yarn taped to the floor, or ropes)
- large tagboard charts (Optional; see Activity D.)
- floor tiles or grids marked off into six-inch squares (Make grids on the floor with chalk or masking tape, or by taping together sheets of newsprint marked with crayon or felt-tip pen.)

PROCEDURE

Activity A

Arrange two large closed curves side by side on the floor, or on a table. Show the children a set of property blocks.

WHAT ARE THESE CALLED? (Blocks.)

THAT'S RIGHT. WE ALSO SAY THAT THESE ARE A SET OF BLOCKS. I AM GOING TO GIVE EACH OF YOU A SUBSET OF THIS SET.

Give each child two property blocks. To be certain that children recognize the properties of the blocks, play a game of "Hold-Up-the-Block." Each child who has a block with the property you name should hold that block high for all to see. Any mistakes should be corrected by the child as you go. These properties should be mentioned one at a time: shape -- circular, triangular, square; color -- yellow, red, blue, green; thickness -- thick, thin; size -- large, small. If some children need more work with this, invite one child at a time to replace you as caller in "Hold-Up-the-Block."

Hold up a block -- for example, a large, thick, blue square block. Ask the children to:

HOLD UP A BLOCK THAT IS NOT BLUE.

HOLD UP A BLOCK THAT IS NOT SQUARE.

HOLD UP A BLOCK THAT IS NOT LARGE.

HOLD UP A BLOCK THAT IS NOT THICK.

Repeat with other blocks.

Then identify the two closed curves of yarn:

WE ARE GOING TO MAKE TWO SUBSETS OF THE
PROPERTY BLOCKS THAT YOU HAVE. WHAT
PROPERTIES COULD WE USE FOR SORTING
THEM?

Repeat by pairs the properties they suggest.

ONE SUBSET WILL GO IN THIS CLOSED CURVE
AND ONE OTHER SUBSET IN THIS ONE.

Be sure, in assigning this next task to the children, that you choose only properties where no intersections are possible -- where the children can only make subsets of the same property, such as "thick, thin," "red, not red," etc. The task is to have the children sort a few blocks into the closed curves, using one pair of properties at a time. Suggested pairs of properties are:

yellow and blue
green and not green
circular and triangular
square and not square
thick and thin

red and yellow
blue and green
square and circular
blue and red
large and small.

Now secretly choose a property for each of the curves and put a few blocks in each yourself. Ask the children to tell the names of the properties you used for sorting. If they can't, let them do it by trial and error while you say yes or no. Ask them to keep looking at the blocks inside each curve to see what is alike about the blocks within the curve,

and what is different from those in the other curve. Continue until someone is able to describe the properties. Let the rest of the children who have appropriate blocks sort them.

Repeat with other pairs of properties. Be sure to include some of the "green/not green" types of sorting.

Ask the children to help you in sorting the property blocks back into sets after this or any of the following activities. Use floor tiles if your room has them, or lay a large paper grid on the floor. Help the children get started by placing the bottom row of blocks for them, one of each color. Ask them to place the blocks of the same color, one per space, above the bottom one, so that the result is a column of blue, a column of yellow, a column of green and a column of red. This will provide some histogram activity in preparation for Lesson 7. When the children have sorted out the blocks on the grid, it is easy to sort the blocks into sets.

Activity B

Arrange two closed curves as in Activity A. Give each child a subset of two property blocks. Ask the class to name properties that could be used for sorting. Then decide with the children on a pair of properties by which to sort the blocks into the closed curves.

Ask all the children who have a block with one of the two properties to put it in the appropriate closed curve. Repeat for the second property. Have children check each other to see that no block belonging to either subset is outside the curves.

Now pick up the curves and have some children push the two subsets together. Tell them that when you put subsets together like this, you call it a "union" of sets. Have the children collect their two blocks (or two others if they have forgotten) and repeat the activity with another pair of properties. For variation, call on children -- one at a time -- to name the properties for sorting into subsets and then have classmates place their blocks appropriately.

Activity C

Distribute two property blocks to each child, and arrange closed curves of yarn on the floor as for Activities A and B. Now choose one pair of properties from this list. Each will describe the subset in one of the closed curves of yarn.

red and circular
blue and square
yellow and triangular
blue and circular
green and square
red and triangular
green and circular
yellow and small
triangular and thick

Call on each child who has a block with either property to come forward and place his block. Allow the children to put their blocks in the category they choose, even if it belongs in the intersection. Either when they have all finished, or when a child recognizes the problem (that his block belongs in both places), ask:

IN WHICH SUBSET DOES THAT BLOCK BELONG?
(It belongs in both subsets.)

IS THERE ANY WAY TO PUT THE BLOCK IN BOTH
SUBSETS?

CAN YOU FIGURE OUT A WAY TO PUT THE BLOCK
IN BOTH CURVES AT ONCE? YOU MAY MOVE
THE CURVES IF YOU WISH.

When the curves overlap:

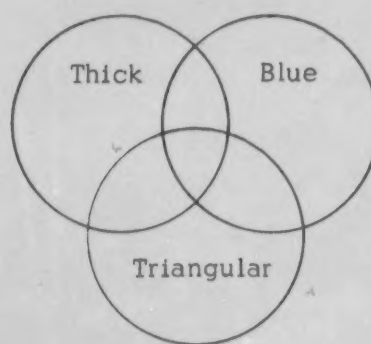
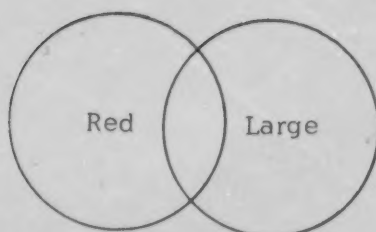
NOW, WHERE WILL YOU PLACE YOUR BLOCK --
IN THE SUBSET OF RED BLOCKS OR IN THE SUB-
SET OF CIRCULAR BLOCKS?

When someone points to the area which overlaps:

THAT PLACE HAS A SPECIAL NAME. IT IS
CALLED THE "INTERSECTION."

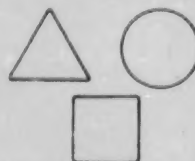
Supplementary Activity

Set out large tagboard charts with overlapping closed curves and label each curve with a property. Have the children sort blocks into these curves during their free time. Each child should sort a set of blocks into the appropriate curves. Two examples of such charts are as follows:

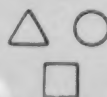


Activity D

The basic rule in this activity is to copy a pattern of blocks with other blocks, but to make a change in one property. For example, if we have a pattern of large, thick, blue blocks such as this:



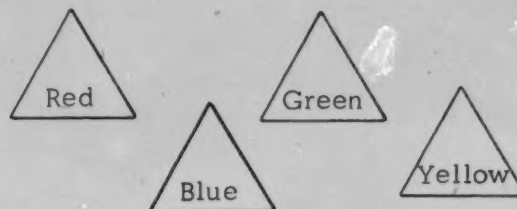
we could transform the pattern to small, thick, blue blocks --



-- or to large, thick, red blocks

-- or to large, thin, blue blocks, etc.

Another way might be to start with pieces of the same shape and size, but in different colors:

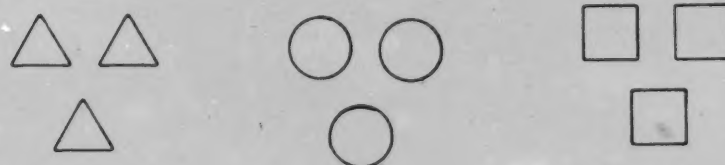


The above pattern could be copied in large circles or squares or in small triangles in the same colors as the first pattern.

You may find that a display of successive transformations made of blocks (or of construction paper cutouts) pasted on tagboard is very helpful in supplementing your demonstration of this procedure to the children. Begin your demonstration with very simple patterns. Then make a pattern and ask the children to do what you have been doing -- make a copy with a change in one property. Have another child copy the first child's pattern, changing one more property. Continue in this way, leaving the row of transformations in view. Frequently take time to review what is happening.

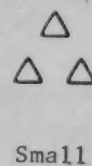
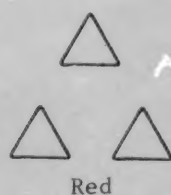
When some of the children seem to understand the process, give them a set of blocks and allow them to move to another corner to work. Ask volunteers to make a pattern and to transform the pattern by one property. Continue with the others until they are all able to transform simple patterns.

Examples of transforming patterns, one property at a time:



For large thick blue triangles, the property shape is changed and changed again.

The color and then the size is changed:



Lesson 7: SORTING LEAVES ON A GRID

COMMENTARY

Arrange to take the class outdoors. This time the children will collect leaves which they will examine in the classroom for various properties and will sort into subsets according to one or two chosen properties. Hopefully, this first activity will make children aware of many of the properties of leaves while reinforcing the idea that it is possible to make many subsets of the same set of objects.

In Activity B, the children arrange the two subsets of their leaves into parallel vertical columns. They will discover that this is not a good way to decide which subset has more leaves -- if the leaves in one subset are larger than those in the other subset. After the children realize there is a difficulty in pairing leaves when they are placed side by side in columns this way, a grid is used. When one leaf is placed within one square of the grid, the relative number of each set can easily be seen.

The comparison of subsets by using a grid is an introduction to methods of representing distributions of properties in a population (here a population of many leaves). Such skills and ideas become much more important later in measurement, statistics and biology.

MATERIALS

-- for the class --

- grid, using floor tiles or six-inch squares marked on floor or on large sheets of paper taped to the floor

-- for each child --

- 1 plastic bag for collecting leaves
- set of 5 leaves to be collected outdoors. (If absolutely necessary because of the season or locale, vegetable leaves [lettuce, celery, carrot top, etc.] or leaves from indoor plants may be substituted.)

PROCEDURE

Activity A

Take the children outdoors to collect leaves. Give each one a plastic bag and instruct him to collect five leaves. But before the children start collecting, have them look at, and describe informally, some trees, leaves, grasses and weeds. Call their attention to some comparisons by asking whether the leaves from one bush look like the leaves from another, etc.

Leaves that are collected should not be dry and brittle. They should be whole; and they should not all be collected from the same place, because variety is desired. For example, poplar, oak, elm and maple leaves are quite different in appearance and easy to handle. If trees and shrubs are scarce, grass leaves and weed leaves can be collected. Consult the Minnemast handbook, Living Things in Field and Classroom, for suggestions, and also for help in identification. (Although identification of plant types is not a part of this lesson, by all means help the children find out the names of the plants if they want to know.)

When the children have brought their bags of leaves back to the classroom, put a few drops of water in each plastic bag if they are to be kept for another day (or keep them all together in a bag with a wet sponge). If they are to be used immediately, have the children take them out and look at them.

WHAT PROPERTIES DO YOUR LEAVES HAVE?

Encourage comparison between children of their various leaves, noting any uncommon kinds they have collected.

WHO CAN THINK OF A WAY TO SORT AND MAKE TWO SUBSETS OF HIS LEAF COLLECTION? WHAT PROPERTIES WOULD EACH OF YOUR SUBSETS HAVE?

Call on another child to bring his set forward and arrange them in subsets, as "all green" and "green with a little yellow," "jagged edge" and "smooth edge," "long" and "short."

Challenge the other children with the question about the subsets and tour the class as the children organize and show you their work. Ask them to name the property they are using to make the subsets, and encourage them to make new subsets according to different properties. They may not be able to answer specifically what is similar or alike in their subsets. This is acceptable, as your questions alone suggest to them that there ought to be some common property. In these instances, guess some properties that look possible from the arrangement, asking only for yes and no answers. Or you might ask, "Why did you put all the large leaves in this subset? Was size the property you used for sorting?"

Suggest that the children look closely at the leaves -- at their edges, ends, veins, hairs, and at their upper and lower surfaces. Suggest, too, that they try to see through them. Such close inspection may give them many more properties by which to sort.

Activity B

Divide the class into groups of three or four children and have each team work with their combined leaf collections. This combination of fifteen to twenty leaves should be divided into two subsets on the basis of a property that you select, such as "green" vs. "not green," "pointed end" vs. "rounded end," "green" vs. "green with some other color," or some textural property. Depending on the variety of leaves, you may wish groups to use different properties for making their subsets.

Ask the teams of children to place the leaves of each subset in two vertical columns, side by side on a table. After each group has done this, ask questions such as these:

WHICH SUBSET HAS MORE LEAVES? HOW DO YOU KNOW?

WHICH COLUMN IS LONGER?

HOW MUCH LONGER IS IT? (Longer by two leaves, three leaves, etc.)

ARE YOU SURE THERE ARE MORE LEAVES IN THIS COLUMN?

If necessary, point out the varied sizes of the leaves -- two of one kind take up as much room as one of another kind, etc.

IS THERE ANY WAY FOR US TO TELL QUICKLY WHICH SUBSET CONTAINS MORE LEAVES AND HOW MANY MORE IT HAS?

The object of this question is to get the children to think of a way of comparing other than by counting. After some discussion, offer the grid. Have the children compare the vertical columns of the grid.

IS ONE COLUMN LONGER THAN THE OTHER OR ARE THEY OF THE SAME LENGTH? (They are both the same in length.)

Now have the children move their leaves, one by one, to the squares in the two columns of the grid, starting at the bottom. If one subset contains more members than the other, it will be apparent from the difference in the lengths of the columns of leaves. Ask whether the subsets have the same number of members or whether one subset has more members. How many more? Have the children circulate about the room to make quick checks of the two subsets in each grid. They may notice and discuss with each other the differences in number of members in each subset. If they do not notice this, call their attention to the differences in lengths of the columns.

Lesson 8: INTERSECTION OF SETS

COMMENTARY

This lesson provides more experience with grouping objects on the basis of two different properties (color and size). The objects are buttons. Two colors and two sizes are represented, and four intersections are possible. Children are not given closed curves of yarn this time, but instead are challenged to sort their subsets with no prop except a sheet of paper that has been ruled horizontally in half. With minimal instruction, the children should try to arrange buttons of one color above the line and buttons of the other color below the line. They should then make subsets according to size within each of the color subsets, and next try to find a way to mark off these new subsets with a crayon. They may readily discover that a vertical line is an effective divider. But, in any case, their final arrangement will have rows (horizontal) denoted by properties and columns (vertical) denoted by properties. Each button will have a row property and a column property.

MATERIALS

-- for each child --

- 8 buttons (two small blue, two large blue, one small white, three large white)
- 1 sheet of construction paper with a horizontal line dividing it in halves
- any of the following are optional materials for reinforcing concepts:
 - macaroni (two shapes, two sizes)
 - bird pictures (two shapes of birds, two sizes of birds)
 - beans (kidney, lima, navy, etc.)
 - cat pictures (wild, tame, spotted, striped or solid color)

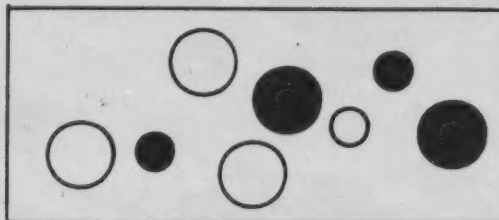
- plant and animal pictures from Lesson 4. Animals should show variety in number of legs, fur or feathers (coverings), mode of locomotion, etc. Plant pictures should show variety by shape of leaves, number of petals, etc.
- property blocks

PROCEDURE

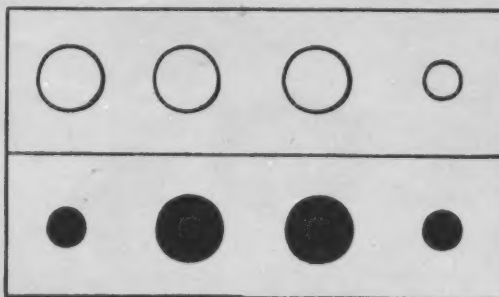
The following procedure uses buttons, but other objects may be substituted or used to supplement the activity presented here.

Guide the children through these steps:

1. Give each child a sheet of the construction paper across which you have drawn a horizontal line, but place it on his desk with the blank side up. Then give each the set of buttons specified in the materials. Have the children examine the properties of the buttons and tell you whether they think they can make any subsets of these objects.

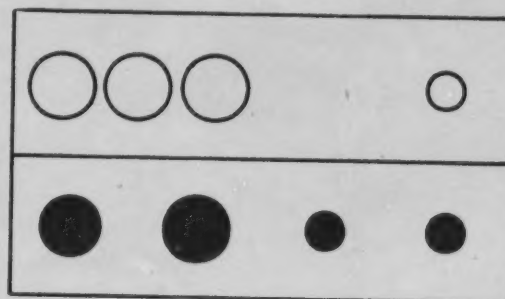


2. Next have the children turn their papers over. Ask them to place the blue buttons in the lower row and the white buttons in the upper row. Have them describe the two subsets they make: blue buttons and white buttons.



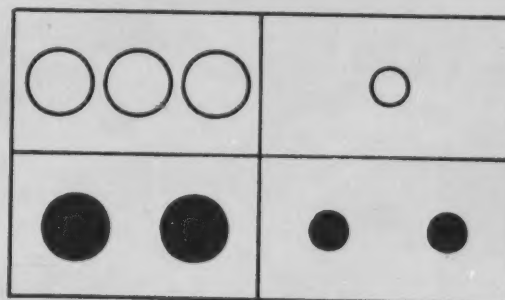
3. Now ask the children if they see any subsets among the blue buttons. They should recognize that there is a subset of large blue buttons and a subset of small blue buttons. Ask them to separate these two subsets by placing them to the left and to the right of the lower row on the paper. Now the children will undoubtedly tell you that corresponding subsets can be made for the white buttons. Let them do this. The arrangement should be this:

Draw a diagram on the chalkboard.



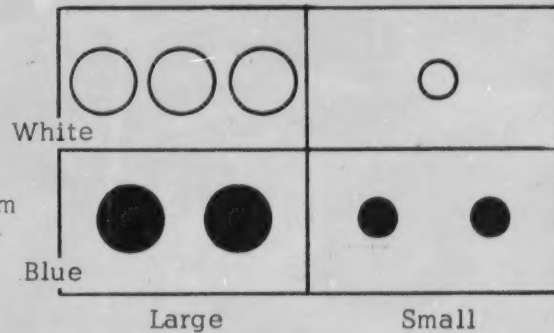
4. With a crayon, each child should separate the subsets by drawing a vertical line on his paper. He should be able to tell you that he has four subsets, and to describe the properties that define each.

Draw a vertical center line on the chalkboard diagram, after the children have done so on their papers.



5. Point to the two pairs of blue buttons in the bottom row and have the children tell you what subset that is. Print the word "Blue" beside that row. Repeat for the upper row and for each of the columns.

Elicit the names for the horizontal rows, then for the vertical columns and write them on the board with your diagram, as shown.



6. Now make a game of naming an intersection and having a child point it out to you. The four possible examples you can name are:

THE INTERSECTION OF THE SUBSET OF
BUTTONS THAT ARE BLUE AND THE SUBSET
OF BUTTONS THAT ARE SMALL

THE INTERSECTION OF THE SUBSET OF
BUTTONS THAT ARE BLUE AND THE SUBSET
OF BUTTONS THAT ARE LARGE

THE INTERSECTION OF THE SUBSET OF
BUTTONS THAT ARE SMALL AND THE SUBSET
OF BUTTONS THAT ARE WHITE

THE INTERSECTION OF THE SUBSET OF
BUTTONS THAT ARE LARGE AND THE SUBSET
OF BUTTONS THAT ARE WHITE

Optional Activity

Follow the above procedure with other objects differing by two properties, and with objects for which more intersections are possible, using macaroni, beans or pictures -- as suggested in the materials list.

Lesson 9: SORTING INTO SUBSETS BY THREE PROPERTIES

COMMENTARY

In this lesson children are challenged to group members of a set by three different properties. The children are again the set of objects, and the properties include sex, handedness and a third property they might help to choose (such as a color of clothing or type of shoe).

PROCEDURE

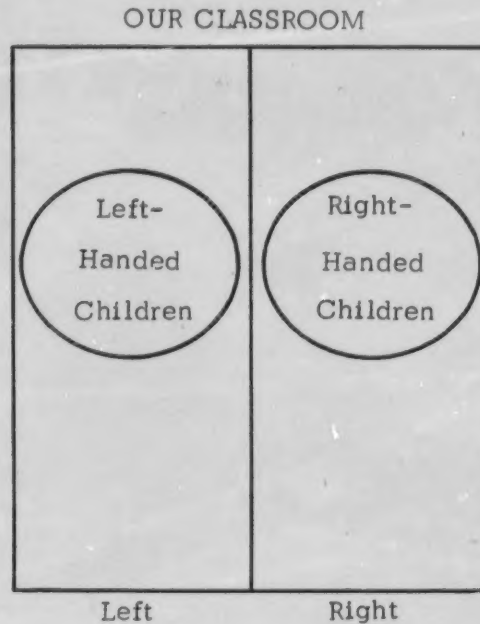
Tell the class that they are the set, and that again they will sort themselves into subsets according to some of their properties. Have the children recall and tell you about the properties they used to make subsets of themselves previously. Then ask them to suggest a third property that could be used to form another subset. If they do not suggest something practicable, have them look at each other for properties. Lead them to notice colors of clothing, types of shoes, etc., so that the result is something like "those wearing something red and those not wearing something red," "sneakers vs. shoes," or "glasses vs. no glasses."

Announce that you wish to divide the class into subsets according to three properties: (1) handedness -- right or left, (2) sex -- boy or girl, and (3) wearing something red or not wearing something red.

FIRST LET'S START WITH THE PROPERTY OF HANDEDNESS. ALL LEFT-HANDED CHILDREN PLEASE GO TO THE LEFT SIDE OF THE ROOM. Indicate the side of the room that is on the children's left.

WHAT SUBSETS DO WE HAVE NOW? (A subset of left-handed children on the left side of the room and a subset of right-handed children on the right side of the room.)

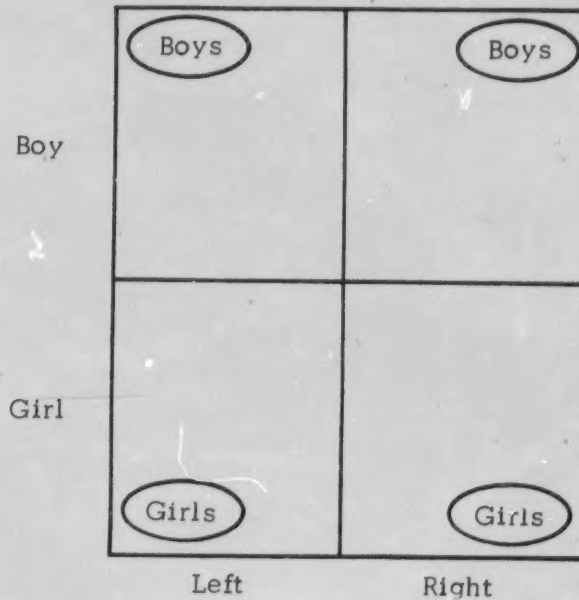
Draw a diagram of the room on the board, showing a vertical line. Beneath the left column, print "Left." Beneath the right column, print "Right."



ALL LEFT-HANDED CHILDREN NOW MAKE A SUBSET OF BOYS AND A SUBSET OF GIRLS. EACH NEW SUBSET SHOULD GO TO ONE OF THE TWO CORNERS OF THE LEFT SIDE OF THE ROOM. Indicate left front corner for boys, left rear corner for girls.

ALL RIGHT-HANDED CHILDREN, PLEASE MAKE A SUBSET OF BOYS AND A SUBSET OF GIRLS. EACH NEW SUBSET PLEASE GO TO ONE OF THE TWO CORNERS ON YOUR SIDE OF THE ROOM. Indicate right front corner for boys, right rear corner for girls. Label the rows of your board diagram "Boy" and "Girl."

OUR CLASSROOM



WHAT SUBSETS DO WE HAVE NOW? (A subset of left handed boys in this corner, a subset of right-handed boys in this corner, a subset of left-handed girls here, and a subset of right-handed girls here.)

THERE IS A THIRD PROPERTY YOU ARE GOING TO USE TO MAKE MORE SUBSETS. TELL ME WHAT THAT THIRD PROPERTY IS. (We are going to make subsets of children wearing something red and children not wearing something red.)

WE HAVE ALREADY USED UP ALL FOUR CORNERS OF THE ROOM. WHERE SHOULD WE PLACE THE RED AND NOT-RED SUBSETS OF CHILDREN?

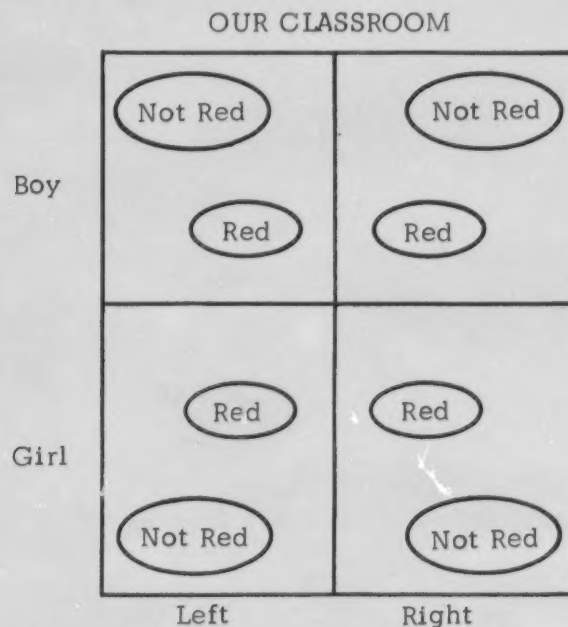
Elicit as many plausible arrangements from the children as possible. Remind them, if necessary, that the children who will be in the "red, not-red" subsets have already been placed according to whether they are (1) left or right-handed and

(2) according to whether they are boys or girls, and that they will have to remain in parts of the room appropriate to these two properties.

Commend all good suggestions, but finally say that you have decided that all red subsets in each corner shall place themselves near their own not-red, but a little closer to the center of the room. Show on the diagram how the children are to do it. Then ask one group at a time to make the "red, not-red" subsets:

WILL THE SUBSET OF RIGHT-HANDED GIRLS NOW FORM SUBSETS OF THOSE WEARING RED AND THOSE NOT WEARING RED? THOSE NOT WEARING RED, PLEASE STAY NEAREST THE CORNER. THOSE WEARING RED, LEAVE A LITTLE SPACE BETWEEN YOURSELVES AND YOUR NOT-RED SUBSET, AND MOVE IN A LITTLE CLOSER TO THE CENTER OF THE ROOM.

Help arrange the subsets of "red, not-red" children. Then fill in the chalkboard diagram, as shown below, and ask the children to remain in their places.



Each of the eight subsets is now an intersection of three sets rather than two, as you can demonstrate to the children later. But now, while they are still in place, question them about the location of the set of all boys, the set of all right-handed children, etc.

Ask questions about the location of each subset by describing its properties.

WHERE ARE THE BOYS?

WHERE ARE THE BOYS WITH NO RED?

WHERE ARE THE GIRLS?

WHERE ARE ALL THE CHILDREN WITH RED?

WHERE ARE ALL THE GIRLS WITH RED?

WHERE ARE ALL THE GIRLS WITH NO RED?

WHERE ARE ALL THE LEFT-HANDED CHILDREN? Etc.

Extend the lines of your chalkboard diagram and let children point out to you the subsets and their intersections, if they wish. The board diagram may help clarify the idea of intersection for some of the children.

Ask a child to draw a closed curve on the chalkboard around the subset of all children wearing red. This should not be too difficult because the four subsets of children wearing red are represented by closed curves near the center of the diagram. If no child can do it, draw the curve yourself and have the children discuss whether you have done it correctly.

Call on children, one at a time, to describe the three properties of each subset in the chalkboard diagram as you point to each or trace the curve that contains it.

If the children seem to be having difficulty in identifying the subsets, review the entire activity by starting another identical chalkboard diagram and filling in the subsets as they describe each one and show you where to place the closed curve that contains it.

Lesson 10: TREE DIAGRAMS

COMMENTARY

Activity A introduces the concept of a tree diagram to the children. You do this by reading a story about a river to them. In the story two boys navigate toward the source of a many-branched river of soda pop. At each fork in the river they must decide which of the two branches (rivers) to take. They base their decisions on the properties of the soda pop specified for alternate branches. The children follow the route of the boys on Worksheet 5, which is a diagram of the rivers. In this lesson the idea of making a choice between two properties at an intersection is a means for grouping objects according to three different properties.

Activity B reinforces the concept of a tree diagram by involving the children physically. They sort themselves at each of three intersections according to three properties, taking one property at a time. They do this outdoors, or in a large multi-purpose room, using a tree diagram laid out with rope, chalk or whitewash.

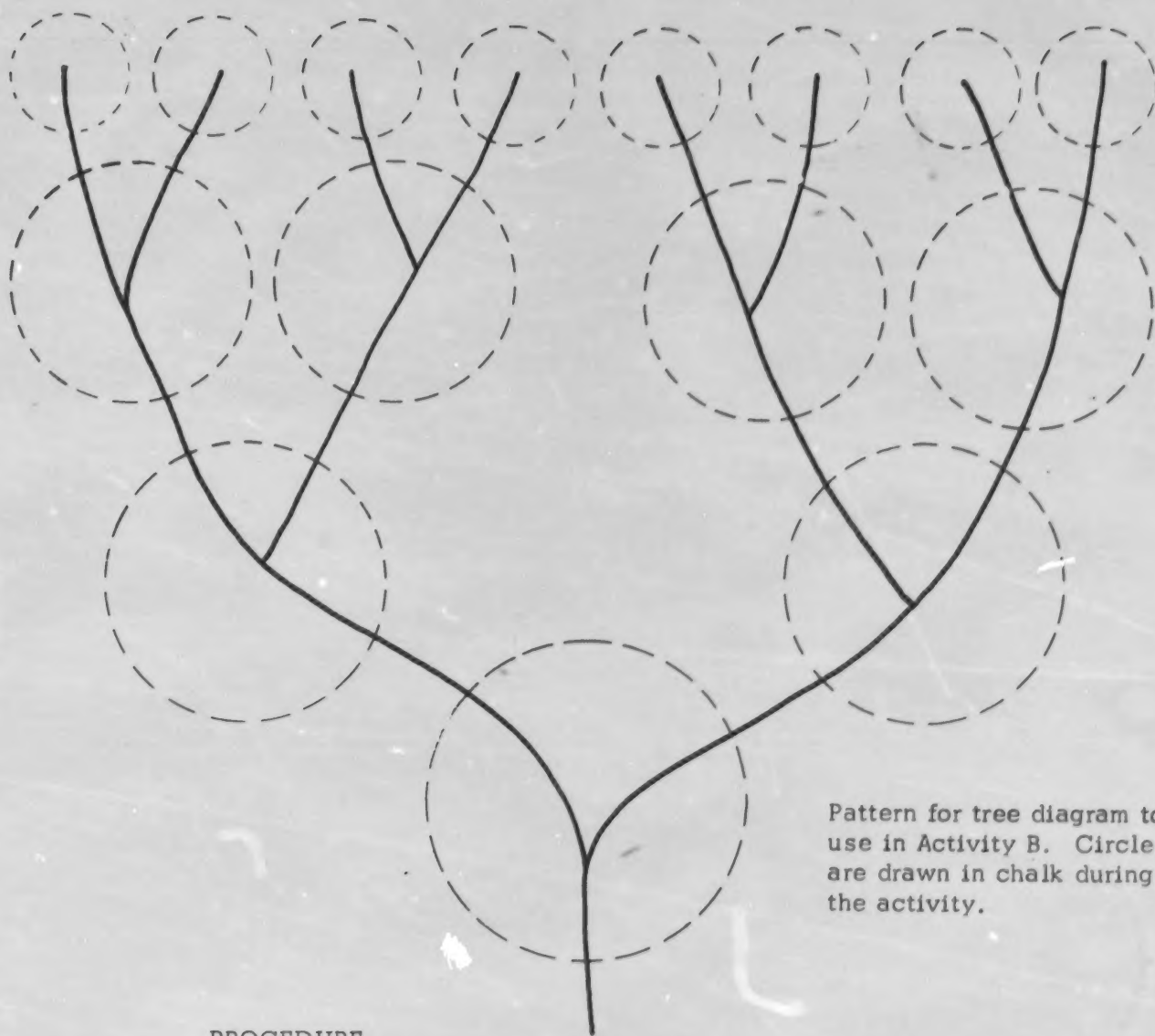
MATERIALS

-- for the class --

- story in manual, "A Trip Up The River"
- large tree diagram made with chalk, whitewash, or rope, over area at least 48 by 48 feet. 100 feet of rope are provided in teacher's kit. The rope can be cut into appropriate lengths for this lesson, but all pieces should be saved for use in Unit 10, Describing Locations. This tree diagram should follow the pattern shown on the next page.

-- for each child --

- Worksheet 5, diagram for "A Trip Up The River"
- 1 brown, 1 orange, and 1 purple crayon



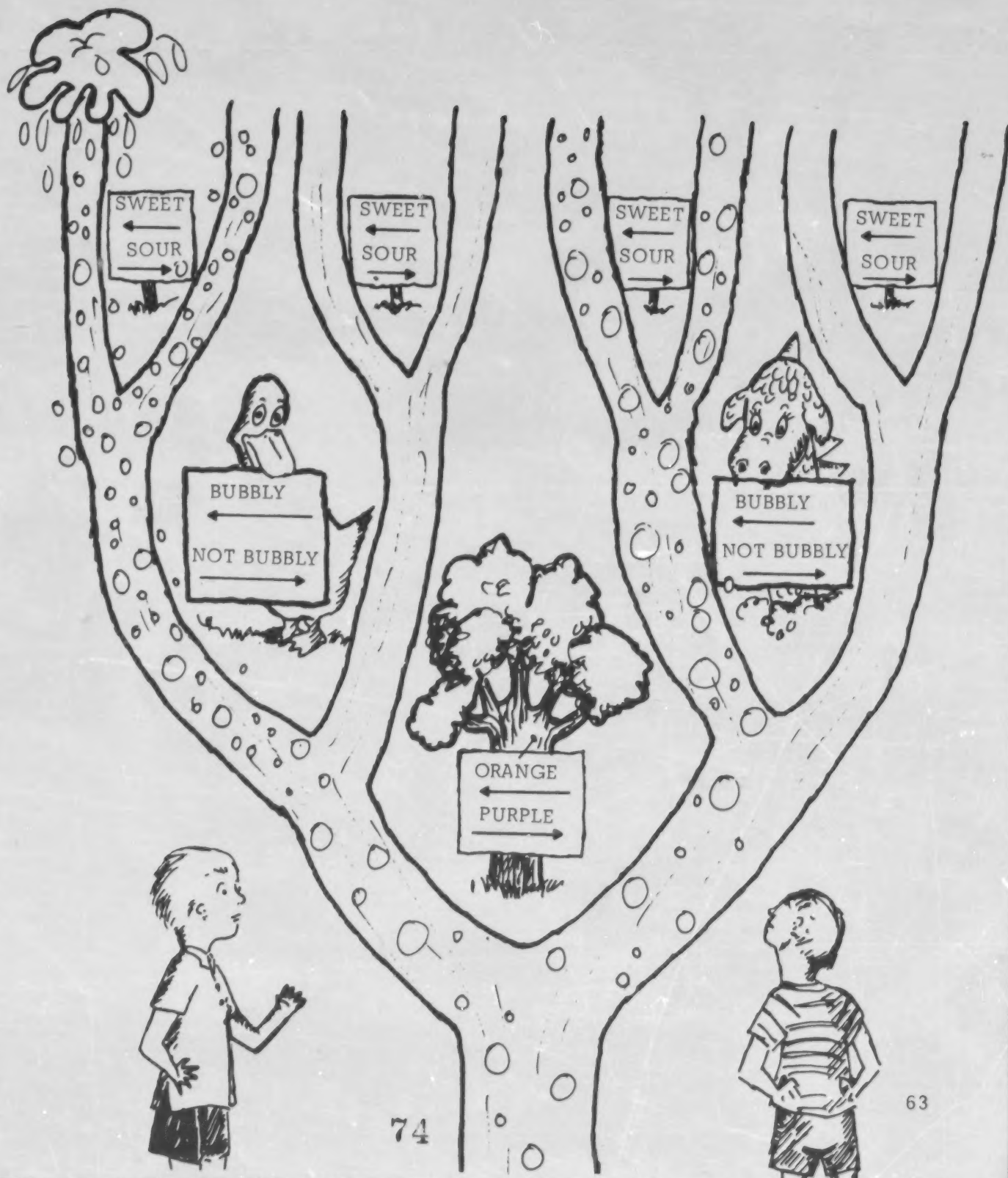
PROCEDURE

Activity A

Distribute copies of the diagram worksheet for "A Trip Up The River" to the children, but do not distribute the crayons at this time. Read the story to the children, stopping at

the place indicated in the text to distribute a brown crayon to each. After the children have colored the appropriate part of the diagram, collect the brown crayons and continue reading the rest of the story. Then give each child an orange crayon for coloring the rest of the route the boys took. Next, have the children respond to the questions listed at the end of the story.

Later you might ask each child to mark the route he would have taken to arrive at the kind of soft drink he likes best. The children might also use their worksheets as a drawing activity. To have them do this, suggest that they draw a picture of whatever they think they would find along the seven other paths, or at the end. Ask them to color their rivers appropriately. At this time the children will need purple crayons.



A Trip Up The River

Alan and Bob were sitting in an old wooden canoe, paddling up a strange-looking river. The river was very wide and slow moving. It was an ugly-looking, brown color. The water had an odd appearance. Every once in a while small bubbles floated up from the river bed and popped on reaching the surface. One wave was smooth, but the next was bubbly, then smooth again, then bubbly. Alan dipped his finger into the river. Then he licked it. "This tastes awful," he said, wrinkling up his nose.

Bob tried it too. "Why, this tastes sweet. No, I think it tastes sour."

"Which is it?" Alan asked.

"It's both," Bob said. "It's sweet and sour and, ugh, it tastes awful!"

"I think it tastes something like pop," Alan added. "That's what it is. It's a mixture of lots of different kinds of pop."

"Maybe if we paddle up this river, we can find out where it's coming from," Bob said.

Alan and Bob soon came to a place where the river divided. On one side there was a river with orange water in it and on the other side was a river with purple water in it.

"Which one do we take?" Alan asked Bob.

"How should I know?" Bob asked. "But look, there's a sign on that tree at the fork where the rivers branch out!" The sign had arrows and showed that the orange river was to the left and that the purple river was to the right.

"Which one shall we take?" Alan asked impatiently. The two boys looked around. Orange water from one side was mixing with purple water from the other side. "That's why the river is such a terrible brown color!" Alan shouted.

"Oh, don't get so excited," Bob said. "Let's sit down and think about all this. I have a feeling that if we take the orange river and it branches out again we might find that one branch has orange and bubbly water and the other has orange and not-bubbly water. If we take the purple river, we might get a river with purple and bubbly water or a river with purple and not-bubbly water. I had better make a map of the rivers as we go along."

Give the children each a brown crayon and ask them to color the river up to its first intersection. Then collect the crayons.

"We still don't know which way to go," Alan grumbled.

"I'm just as curious as you are," Bob replied, "but let's try the orange."

So they paddled up the orange river until they reached another place where the river divided. There were two ways they could go. One way was all bubbly. The water bubbled up in tiny bubbles and popped in the air. On the other side was a river with very smooth glassy water with no bubbles. Alan looked at himself reflected in the orange, not-bubbly river and said, "How strange, I look all orange!"

"I'll say it's strange," Bob answered. "Now I know why the river behind us had some bubbles in it. It looked a little fizzy because the bubbly river and the not-bubbly river mixed together."

"But we still don't know which way to go," Alan said. "Maybe we can find another sign." He looked around and -- much to his surprise -- saw a big, blue goose sitting on the bank of the river. In its mouth it had a big sign. Alan walked up to the blue goose.

"Honk," the goose greeted Alan, and the sign fell right out of its mouth.

"Honk," Alan said back to him. Then he picked up the sign and showed it to Bob.

The sign was very much like the first one, except that now it showed that "BUBBLY" was to the left and "NOT BUBBLY" was to the right.

"Aha! Just as I thought," Bob said. "Now I have a hunch that if we go either way, we'll find two more rivers."

"Why? What kind of rivers? What do you expect to find?" Alan asked.

"You ask too many questions, Alan," Bob said. "Let's take the bubbly river and let me fill this in on my map."

So the boys paddled the canoe up the bubbly orange river. Finally they came to two more rivers.

"Look, the sign says that one is sweet and the other sour!" Bob exclaimed.

Alan tasted the water in one of the new rivers. "It tastes exactly like sweet, orange, bubbly pop," he said. "Why, we are paddling up a river made of pop!"

"Let's paddle over to the other river and taste that," Bob said.

Sure enough, this river tasted just like an orange, not-bubbly, sour drink. Without saying a word to each other, they paddled as fast as they could up the orange, bubbly, sweet river of pop. The river soon ended and there was a large fountain in the ground out of which the pop flowed.

"This is wild!" Alan exclaimed. "Why, this is where all that orange, bubbly, sweet pop is coming from!"

Then he and Bob drank so much of the wonderful, sweet, bubbly, orange pop that they could hardly move.

Give the children each an orange crayon
and ask them to color their worksheets
appropriately.

"Let's go, Bob," Alan finally said; "I want to explore and see if there are some more rivers."

"I'm too full; I'm not going to budge," Bob answered. "Besides, I think I already know what we'd find."

Finis

(Suggested questions to ask about the story are given on the next page.)

DO YOU KNOW WHAT THE BOYS WOULD
FIND?

HOW MANY FOUNTAINS DO YOU THINK
THERE ARE?

WHAT KIND OF POP WOULD FLOW FROM
EACH OF THOSE FOUNTAINS?

WHAT DO YOU THINK THE PURPLE RIVER
TASTES LIKE?

WHICH RIVERS WOULD YOU HAVE CHOSEN?

WHAT KIND OF A FOUNTAIN WOULD YOU
EXPECT TO FIND?

Activity B

For this activity you will need the large tree diagram described in the materials list at the beginning of the lesson. The diagram may be whitewashed or drawn with chalk, or made of rope. It requires a large area and so should be placed outdoors on the playground or on the floor of the multi-purpose room.

Explain to the children that they are going to arrange themselves into subsets along a tree diagram which is very much like the river diagram on the worksheets they used in Activity A. Tell them that all such diagrams are called "tree" diagrams and let them guess why.

Draw a tree diagram on the board to show them what they are going to do. Say that first they will form themselves into a set which is called "the set of all children in this class." At the first intersection they will divide into subsets according to the property of handedness: all the left-handed children will take the branch to their left and all the right-handed children will take the branch to their right. At the second intersection or branching, they will form subsets according

to their sex: all the boys will go to their left and all the girls will go to their right. At the third intersection, they will divide again according to the property of whether they are wearing some clothing that is red in color or not wearing some clothing that is red: All who are wearing red will go to the left and all who are not wearing red will go to the right.

When you take the children outdoors (or to the multi-purpose room), take along some chalk or rope with which to make closed curves around the entire set and then around each subset. Be sure to make closed curves around all empty sets, too.

A good way to proceed is to have all the children stand in a single group at the base of the tree diagram. Then leave the group and walk to the intersection. From that point, instruct each child where he should go, according to his handedness. When the two subsets are formed, draw the closed curves around them.

Proceed at the next intersection for the group on the left, and then for the group on the right. When they are divided according to the two properties of handedness and sex, they will be standing in four subsets (one or more of which may be empty). Draw closed curves around each of the four subsets.

Repeat the procedure at all four intersections for the next property -- color of clothing -- and the children will see that there are now eight subsets (one or more of which may be empty). Draw curves around each of the eight subsets.

It is important that all the children now be able to state the properties which describe the subsets. If they cannot do this, repeat the activity.

If the children seem to be enjoying the sorting, you might have them choose another property to substitute for color or for handedness. They might like to sort themselves according to such properties as "wearing glasses and not wearing glasses," "wearing blue and not wearing blue," etc.

When you return to the classroom, draw the tree diagram on the board again. Label the subsets with the appropriate properties. Then ask individual children to point to the subset of which they would be members.

SECTION 3 TESTING FOR PROPERTIES

In previous lessons, children identified some conspicuous properties of objects, including color and shape. They physically arranged objects into subsets on the basis of the properties they observed. In this section, children again identify properties and manipulate objects, but here the process is intended to emphasize and expand their understandings of properties as such. Children are introduced to experimentation as a means for identifying properties, and they discover the importance of a control object in an experiment. They also discover that there may be a qualitative order for a given property.

A live and a dead dry cell battery look and feel alike, but a flashlight bulb may be lighted only when the live dry cell is used. The capacity to light a bulb is a property that the two dry cells do not have in common. To discover this property, the dry cells must be tested with a bulb. Similarly, a hard-boiled egg looks like an uncooked egg, but the materials within each shell have different properties. Only by testing (cracking) both shells can these properties be observed. These and other pairs of objects are used in Lesson 11 to introduce the idea that experimentation is necessary to reveal some properties of objects.

Two lessons involve comparisons and relative ordering of properties. In each case, children perform tests to determine which properties vary for similar objects. In Lesson 12, they rub each of several pieces of sandpaper and examine them with a hand lens to find that differently sized grains of sand produce sandpaper of different roughness. In Lesson 13, children stir and pour different liquids to determine that some are thicker and some more watery than others. After experimenting to determine differences, children arrange the objects in order, according to the quality of the given property. Children compare two objects at a time to establish the series. This technique is known as "making a binary comparison."

In experimenting with an object, one or more of its properties may be changed. A paper towel has a definite color, size, shape, and texture. It can absorb water, it can be burned, and it can be torn or wrinkled. By folding the towel, for example,

the shape is changed. Are color, size, texture, and other properties also changed? To answer this, one must recall the appearance of the towel before it was folded. In Lesson 14 children find that memory is not adequate, especially when they want to communicate "before" and "after" observations to other people. One way to recall and to communicate is to use a control object when experimenting. Use of a control object is a technique that involves selecting two identical objects, determining their common properties, setting one object (the control) aside while the other object is altered and, finally, comparing the changed object with the control object. Use of a control object is stressed and developed in Lessons 15, 16, 17 and 18 where the children use clay, ice cubes, souring milk, and balloons to observe changing properties. They investigate some changes that are reversible and some that are not, and they observe how things change with time.

Lesson 11: A HIDDEN PROPERTY

COMMENTARY

Use any of these activities to help children realize that it is necessary to experiment with and test objects to find many of their properties.

MATERIALS

Activity A

- 2 dry cell batteries, one live, one dead — penlight size (If you do not have an old dry cell battery, simply leave a penlight on until it no longer gives light.)
- 1 penlight (single-battery flashlight)
- or --
- 2 dry cell batteries, one live, one dead
- 1 wire paper clip or piece of wire
- 1 penlight-sized light bulb

Activity B

- 2 magic markers, one worn out, one in working condition

Activity C

- 2 eggs, one hard-boiled, one uncooked
- 1 bowl or cup

PROCEDURE

Activity A

Show the class the two dry cell batteries, and ask them to name the properties of both objects. These may include size, shape, color, odor, and markings.

ARE ALL THE PROPERTIES OF THESE OBJECTS ALIKE?

Have the children tell you how these objects are used. They may or may not be able to tell you that batteries are used to make light. Modify the following demonstration accordingly.

Show the children the penlight or the apparatus illustrated below.

HOW CAN WE USE THIS TO FIND ANOTHER PROPERTY OF THE BATTERIES? (We can put the battery inside the penlight.)

WHAT PROPERTY DO YOU THINK WE WILL DISCOVER? (That batteries can make the light go on.)

LET'S TRY IT.

As you place first one battery and then the other in the penlight, or use the apparatus shown in the diagram, keep in mind that children should be helped to recognize that only one battery has the hidden property. (The dead battery does not do anything.) The hidden property, of course, is the capacity of one battery to make the bulb light up. Lead children to the conclusion that they could only find the hidden property by testing.



Battery and bulb with wire (or paper clip) as connector.

Activity B

Show the class two magic markers that appear identical, but of which one is worn out and no longer makes a mark. Ask the children to describe them in terms of properties — color, shape, material, parts, etc.

ARE THESE TWO OBJECTS ALIKE AS FAR AS YOU CAN SEE?

COULD THEY BE DIFFERENT IN SOME WAY?

If no one brings up the property of marking, give a clue by asking:

WHAT ARE MAGIC MARKERS FOR?

After someone answers, ask a volunteer to find out if both markers have the property. Review the procedure for the children, bringing them to the idea that while objects have obvious properties which can be described with careful observation -- and that while we may think that an object has a certain property -- there are also many hidden properties which are revealed only by appropriate tests.

Activity C

Show the class two eggs, one hard-boiled, the other uncooked. Have the children name the properties of the eggs. They will probably conclude that the eggs are identical in color, texture, and in shape.

DO YOU THINK THAT THE PROPERTIES OF THE EGGS ARE THE SAME ALL THE WAY THROUGH?

This could lead to a discussion of differences between the inside and the outside of an egg, or it could lead to a discussion of possible differences between the two eggs at hand. Either should be encouraged.

HOW COULD WE FIND OUT IF THE EGGS HAVE SIMILAR PROPERTIES INSIDE? (A child might suggest cracking the shells.)

Crack one egg shell at a time against the edge of a cup or bowl. Have the children compare the properties of the insides of both eggs with the properties of the shells. Then have the children compare the properties of the insides of the two eggs. You may want to cut the hard-boiled egg in half to broaden the discussion.



Lesson 12: ORDERING GRAIN SIZES OF SANDPAPER

COMMENTARY

This lesson provides an opportunity to stress the importance of observing both by touching and by looking through a hand lens. Previously, children separated objects that had different properties, but here children are confronted with the problem of separating two objects that differ in the quality of a single property. Finally, this lesson is an experience in ordering objects according to the observed qualities of the property.

MATERIALS

-- for each child --

- 1 hand lens (magnifier)
- 3 strips (1" x 2") of sandpaper, one of each of these sizes: fine, medium, extra coarse

PROCEDURE

Give each child one square of fine sandpaper. Have the class describe as many properties as they can by looking at and by touching the sandpaper. Distribute the extra coarse sandpaper to the class, and again have them identify all properties.

WHAT PROPERTIES DO BOTH OF THESE PIECES OF SANDPAPER HAVE? (Shape and size are possibilities. A child may say that both have one rough surface and one smooth surface.)

IS THERE ANYTHING DIFFERENT ABOUT THE TWO PIECES OF PAPER OR ARE THEY EXACTLY THE SAME? (The papers have different color and weight; one is stiffer than the other and the stiffer one is also rougher.)

After a child mentions roughness, ask:

HOW CAN YOU TELL THAT ONE IS ROUGHER THAN THE OTHER? (A child may show you the result of rubbing the paper on his pencil or piece of wood, the desk, etc.)

WHAT MAKES ONE PIECE OF PAPER ROUGHER THAN THE OTHER? (A child might correctly tell you that sand grains on the rougher piece of sandpaper are longer than sand grains on the finer paper.)

Magnifying glasses should be provided for each child to discover or confirm this.

Distribute the third (the medium) piece of sandpaper, and ask:

WHAT PROPERTIES DOES THIS PIECE OF SANDPAPER HAVE THAT THE OTHER PIECES ALSO HAVE? (Size, shape, roughness, etc. are possible answers.)

IS IT EXACTLY LIKE ONE OF THE PIECES YOU HAVE? WHICH ONE? (It is not like either.)

Have the children hold up the roughest sandpaper in one hand and the newly-distributed sandpaper in the other.

HOW ARE THESE TWO PIECES DIFFERENT FROM EACH OTHER? (The medium sandpaper is not as rough as the other piece. This should be determined by hand lens, by rubbing, or both.)

Have the children hold up the smoothest sandpaper in one hand and the newly-distributed sandpaper in the other.

HOW ARE THESE TWO PIECES DIFFERENT FROM EACH OTHER? (The newly-distributed piece is rougher than the other one. This should be determined by hand lens, by rubbing, or both.)

Finally, have the children place the piece of roughest sandpaper near the edge at the top of their desks, and the piece of smoothest sandpaper close to the opposite edge. The

medium paper should be placed between the first two. Now tell the children that arranging things in this way is called "ordering" or "putting in order." Briefly review the process used in the activity, i.e., the comparing of two objects at a time to arrive at an ordered set.

Lesson 13: ORDERING VISCOSITIES OF LIQUIDS

COMMENTARY

By testing four liquids in various ways, children observe and order them according to the property of viscosity. By stirring or dripping and by observing the different rates at which a marble sinks or moves within the liquids, the children judge that some liquids are thicker than others. They then arrange the liquids in order of their thickness or viscosity. The liquids are listed in the materials in order of decreasing viscosity. The liquid at the top of the list is the most viscous (thickest) and the liquid at the bottom of the list is the least viscous.

The following information is intended for you and only indirectly for the children. It may help you at some time to call the children's attention to phenomena observed in the classroom and outdoors, and to relate these to experiences in this lesson. Examples include play dough and sticky asphalt playgrounds.

Whenever two objects move over one another, there is a force opposing the motion. This force exists when, for example, a liquid flows over some solid surface. Also, various layers in a fluid often move at different speeds. These internal forces are molecular in origin and they give rise to the property of viscosity. Both gases and liquids flow readily, and are therefore called "fluids." All ordinary fluids are viscous to some degree. And many substances ordinarily thought of as solids -- such as asphalt and glass -- also flow at various rates, though generally very slowly.

MATERIALS

-- for the class --

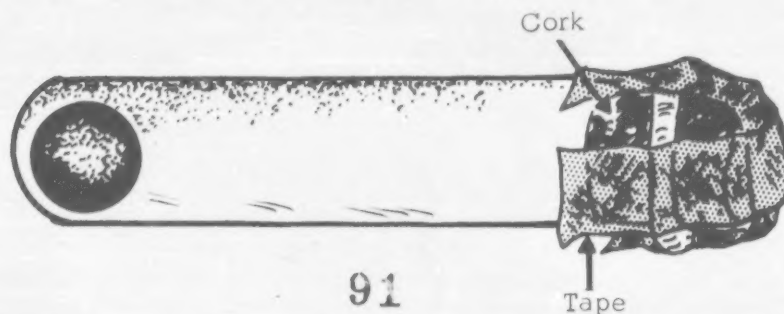
- Viscosity powders in kit or:

- 1 pint corn syrup (If the brand you buy is too viscous, dilute with a few drops of water, but stir well before using.)
- 1 pint heavy mineral oil
- 1 pint vegetable oil
- 1 pint tap water

- 4 clear plastic jars or containers large enough to hold teaspoons
- 4 mustard paddles (or teaspoons)
- 12 glass marbles to drop in jars during lesson
 - for each group of four --
- 4 large clear plastic test tubes
- 4 screw caps or stoppers for test tubes
- 4 glass marbles of a size that will roll freely inside the test tubes
 - for each child --
- Worksheets 6 and 7 in Student Manual A
- crayons: 1 red, 1 blue, 1 green, 1 yellow

A glance at the materials indicates that some cleanup arrangements are necessary. Cafeteria trays will do much to minimize spillage. A pail of detergent solution and a towel should suffice in any kind of accident.

The test tubes should be filled with the four liquids, one liquid per tube in each set of four, and a marble inserted in each tube. Keep the air in each tube to a minimum by filling to the level of the cap before capping or stoppering tightly. Although screw caps are better, stoppers may be used, as shown below.



Similarly, one set of four small open jars should also be partially filled, each to the same level. A teaspoon should then be put in each jar. The jars and spoons are used in Activity A, the closed test tubes in Activity B.

Label each jar and test tube with the following symbols:

- | | | |
|----------------|---------------------------|--------------------|
| corn syrup: | ☐ | (red square) |
| mineral oil: | ☐ | (blue circle) |
| vegetable oil: | <input type="triangle"/> | (green triangle) |
| water: | <input type="rectangle"/> | (yellow rectangle) |



PROCEDURE

Activity A

Place the four jars containing different fluids on a table or desk in front of the class. Do not tell the children what the jars contain. They are to be identified only by symbol. Let some children experiment with the filled jars. You may tell them that each of the four objects in the jars "runs" or "flows" and that such objects are called "fluids." Then ask them if they know other objects that run or flow.

As they observe and experiment, encourage the children to include in their descriptions similarities and differences among the four fluid objects. Because two of the fluids are clear and two are colored, the children may suggest color differences and similarities. Suggest that there are other differences that will interest them.

Now encourage the children to devise their own ways of observing the objects to discover other similarities and differences.

DO THE OBJECTS POSSESS ANY PROPERTIES
THAT HAVE NOT BEEN DESCRIBED BEFORE?
HOW CAN YOU FIND OUT?

Call on volunteers to try their ideas. The spoons should provide a clue, and the children may suggest either stirring the fluids or spooning up each liquid and then pouring or letting it drip back into the jar.

Allow ample time for a number of children to test each of the fluids with the spoons. Soon the children will notice that some of the fluids are thicker than others. Let the children invent their own word or expression equivalent to "thickness." Challenge them to determine which of the four objects is the thickest, which is the next thick, which the next after that, and which is the least thick. Ask other volunteers to place the four fluids in the order of their thickness, with the thickest at their left and the least thick at their right. Continue

the activity until several volunteers and the class are satisfied with the ordering of the fluids.

At this point you may wish to tell the children that there is a special word to describe the thickness of fluids. The word is "viscosity." Thus, the fluids are now arranged in the order of decreasing thickness or viscosity from left to right.

Ask the children to verify carefully the ordering of the fluids. Tell them that there is a special way of comparing that we can use to check the order after it is made. We also use it when working with things that are very difficult to order. Ask them now to check the fluids in the two jars at their left.

DOES THE FLUID IN THE JAR AT THE EXTREME LEFT
REALLY HAVE GREATER VISCOSITY THAN THE ONE
NEXT TO IT?

Ask two volunteers to compare these two fluids and only these two. Ask the two children if they think they can compare better by spooning the two liquids in turn or by spooning them simultaneously. If the children have adopted a stirring method of comparison, encourage them to think about the value of using a "standard" stirring technique for all comparisons. Whatever they decide should become the "official" method of comparison.

Have two more volunteers check the two middle fluids, one against the other, and still two others compare the two fluids on the right. The results of these tests will almost certainly agree with the original ordering because the liquids were chosen for their significantly different viscosities.

Now see that each child has crayons of the same colors as the symbols on the jars. Then distribute Worksheet 6, so the children can record the results of the tests by placing the appropriate symbols in the boxes. If they have trouble drawing the symbols, marks with the appropriate colors are very acceptable.

THE SPOON TEST



Red Mark
or
Symbol: ☐

Blue Mark
or
Symbol: ☐

Green Mark
or
Symbol:

Yellow Mark
or
Symbol: ☐

Now show twelve marbles to the class. Ask the children how these marbles could be used to determine the different viscosities. The children may think of dropping a marble into a liquid to see how quickly it sinks. If they do not, ask them to observe carefully while you drop a marble into the most viscous fluid. Induce them to think about the importance of dropping the marbles.

WHAT WOULD HAPPEN IF I DROPPED A MARBLE
INTO THIS JAR NOW AND ANOTHER MARBLE
LATER?

At this stage, it is neither important nor desirable for the children to relate this new test to the previous one where they used spoons. It is important, however, that the children see the marble test as one way of making a direct comparison test of two fluids according to some common property.

Repeat in its entirety a comparison of ordering, having the children decide the order of two fluids at a time by means of the marble test. This provides you with a good opportunity to evaluate the children's understandings of the previous activity. When the fluids are properly ordered, compare the results of the marble test with the spoon test. The same ordering should be obtained. For some children, this may clarify the idea that, in both tests, they were comparing the same property in two different fluids. Ask for volunteers to describe, if they can, the marble test in terms of the thickness or viscosity of the fluids.

At this point, ask the children to hand in their record sheets. Save these and return them to the children for reference at the end of the lesson.

Activity B

This experiment uses the set of test tubes with their enclosed fluids and marbles. It is recommended that the class be divided into groups of four, and that each group be given one set of four test tubes. This permits each member of a group to have a test tube, even though the group will work together as a team to compare the relative behavior of each fluid and marble.

Distribute Worksheet 7 and crayons of the same colors as the symbols to each child.

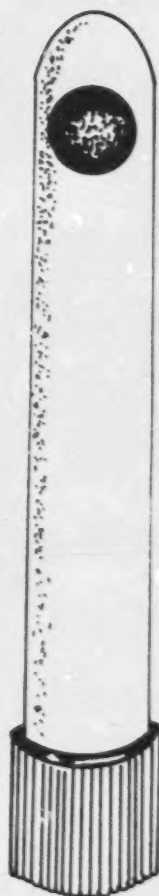
Encourage the children to experiment with the vials. The marble will pass through the fluids quickly or slowly, the way they sank through the liquids in the open jars. However, by inverting the tubes, the behavior may be observed repeatedly. Explain to the class that the fluids used in the tubes are the same ones used in the jars, and the same symbols identify each.

Ask the children whether they can remember better when using only two fluids at a time or when using all four at once. Show them that when they turn all the tubes at once, it is very hard to watch all four marbles at the same time. Once they have decided to watch two at a time, ask what would happen if you turned first one, and then the other. Have them discuss possible ways to turn two tubes at a time so that both marbles start down at the same time. The preferred method is to have one child hold two tubes -- one in each hand -- and invert them simultaneously. The two rates of descent can then be compared with surprising accuracy.

Have each group order their four fluids according to their observations. When they have agreed on the order, have each child enter the order as he did before, the most viscous (thickest) at the left and the least viscous (least thick) at the right. Upon completion of the record sheet, hold a discussion reviewing the binary comparison method and disposing of any remaining problems. Return their copies of Worksheet 6 to the children and have each child compare his new results on Worksheet 7 with his previous ones.

Name _____

THE MARBLE TEST



Red Mark
or
Symbol:

☐

Blue Mark
or
Symbol:

☐

Green Mark
or
Symbol:

Yellow Mark
or
Symbol:

Lesson 14: USE OF A REFERENCE OBJECT FOR COMPARISON

COMMENTARY

Children are asked to experiment with paper toweling to determine its properties. Modify the procedure described below so that the children in your class are impressed with the need for a control object in their own experiments. Activity B is optional but is strongly recommended as a reinforcement of Activity A.

MATERIALS

- 1 roll of kitchen paper toweling
- 5 or 6 large sheets of drawing paper

PROCEDURE

Activity A

Give each of the children a single paper towel from the roll, and have them name the properties of the paper. They will probably name color, shape, and texture, but properties related to the use of the towel are also important.

HOW IS THE TOWEL USED?

WHAT PROPERTIES MUST IT HAVE IN ORDER TO DO THAT JOB? (It must be flexible. It must be able to absorb liquids, etc.)

Hold up a single paper towel for all to see.

LOOK AT MY TOWEL. DOES IT HAVE THE SAME PROPERTIES AS YOUR TOWELS?

WHAT ARE THOSE PROPERTIES? (Children should repeat the list of properties.)

DO YOU THINK IT'S POSSIBLE TO CHANGE SOME PROPERTIES OF THE TOWELS? HOW?

Call for suggestions and let the children try some of them.
An example:

LET'S ALL FOLD OUR TOWELS. LET'S BE CERTAIN
THAT THERE IS A NICE DEEP CREASE IN THE TOWEL.

Fold your towel in about half. The children will probably copy
your pattern, but this is not necessary. Referring to your
towel:

NOW WHAT ARE THE PROPERTIES OF THE TOWEL?

After children name them, emphasize that some properties
have been changed. The towel's shape and texture have
changed. There is a crease where it once was smooth. And
perhaps its size is changed, too. Other properties have not
been changed, including color and properties related to the
towel's use.

The following are questions recommended for eliciting from the
children the need for a control object:

HOW DO YOU KNOW THAT THE SHAPE HAS BEEN
CHANGED? PERHAPS THE TOWEL ALWAYS LOOKED
LIKE THIS. AFTER ALL, IT CAN STILL ABSORB LIQUIDS
AND IT CAN STILL BE WRINKLED UP.

HOW DO YOU KNOW THAT IT HAS BEEN CHANGED?
(Children will probably say that they remember. If
so, pretend with them that you are a stranger who is
seeing a towel for the first time at this moment. You
never saw a roll of toweling before, so you must ask
the children about the towels on their desks.)

WHAT IS THIS?

WHAT IS IT USED FOR?

WHERE DID IT COME FROM? (The roll of toweling.)

HOW DID YOU GET SUCH A LITTLE PIECE FROM
THIS LARGE ROLL? (A child tears off a towel to
show you.)

HOW DID THE TOWELS GET TO LOOK SO DIFFERENT?

A child may offer to fold the new towel, as he did the first one, to show you. Accept the offer, but insist on holding onto a second identical new towel so that you can watch the change and make comparisons as the child folds the towel. After one is folded, hold up the two towels and identify them to the children.

THIS IS THE FOLDED TOWEL AND THIS IS THE
CONTROL TOWEL.

WHAT DOES THE CONTROL TOWEL TELL ME?
(It tells what the other towel looked like before
it was changed, and it helps you check the
changes that are taking place.)

Activity B

Call on three children to participate in an experiment with drawing paper. Have one participant name one property of his paper, and have the others compare to see that all pieces of drawing paper have that property. Repeat until the participants are aware of a number of properties of the papers and of the fact that their papers are identical.

Tell the class that each of the children in the experiment is going to make a change in the paper and then see which properties have been changed and which remain the same. Ask the class to recommend a way for all to be sure of the way the papers looked before the changes are made. They may recall the way they showed the "stranger" how a paper towel looked before it was folded and while it was being folded. Remind them of the word "control." They should use a control drawing paper now. The properties of the control drawing paper should be compared with those of the papers to be changed. All should be found to be identical.

Now ask one child in the experiment to tear his paper once, the second twice, and the third three times.

WHAT PROPERTIES OF THE PAPERS HAVE BEEN
CHANGED? (The number of pieces of paper is
greater.)

Children may suggest that the size of the paper has been changed. There may be disagreement about this. Piecing the paper together on top of the control paper may prove either view, but it represents an important understanding of how a control object can reveal changed properties.

Have the class suggest other alterations that might change certain properties. These might include coloring, wetting, or dropping the paper. Be certain that the children choose a control object before they begin changing the properties of their paper.

Lesson 15: REVERSIBLE AND IRREVERSIBLE CHANGES IN CLAY

COMMENTARY

In this lesson, children identify the common properties of two differently-colored balls of clay, particularly the property of moldability. This property allows the children to change and restore the shape of the ball. The change in shape is said to be a reversible change. After splitting each of the balls in two with a stick, children make two new balls by combining differently-colored halves. One of these is identified as the control ball as children compare its properties with those of the other (test) ball. The control ball is set aside for later comparisons, and the test ball is molded into a variety of shapes. The ball-shape is then restored, and children compare properties of the test ball with the control ball. The distribution of colors is different. Children try to restore the color distribution of the test ball, and find that they cannot do so. The change in color is said to be an irreversible change (one that cannot be reversed by a similar method). The conception of change as reversible or irreversible is important to the children's understanding of properties.

MATERIALS

-- for each child --

- equal amounts of blue and yellow (or any other two colors) play dough, clay, or plasticene; enough for a walnut-sized lump of each color
- 1 craft stick
- 1 large sheet of newsprint

PROCEDURE

Give each of the children two wads of plasticene as specified above, and have them mold each wad into a ball. They should name the properties of the plasticene balls. The colors are different, but the balls are roughly similar in shape, size and odor. Similarities of texture include both smoothness and pliability. Children may or may not mention pliability (squeezableness), so questions should be modified accordingly:

WHAT PROPERTY OF YOUR CLAY CHANGES IF YOU SQUEEZE THE BALL WITH YOUR FINGERS? (Shape.)

EVERYONE USE THE YELLOW BALL TO SHOW ME. Class demonstrates and a child should be asked to repeat that shape has changed.)

DO YOU THINK THAT THE BLUE BALL COULD BE CHANGED IN SHAPE TO LOOK LIKE THE YELLOW ONE? (Guesses.)

LET'S TRY IT. (Reports from the children should tell you that both wads of clay can be changed in the same way -- with fingers. Have the children make up a name for this property. "Squeezableness" is an example.)

NOW, CAN YOU MAKE THE YELLOW CLAY HAVE THE SAME SHAPE IT HAD BEFORE YOU CHANGED IT? (Guesses.)

LET'S TRY IT. (Children should be able to change the shape into a ball.)

CAN THE BLUE CLAY BE CHANGED BACK TO ITS FIRST SHAPE? (Guesses.)

TRY IT. Have the children compare properties of the two balls.

WHEN YOU SQUEEZED THE CLAY BALLS, WHAT PROPERTY DID YOU CHANGE? (Shape.)

WHEN YOU MADE THE CLAY LOOK LIKE A BALL FOR THE SECOND TIME, WHICH PROPERTY DID YOU CHANGE? (Shape.)

HOW MANY OF YOU WOULD LIKE TO LEARN A NEW WORD?

THERE IS A NAME FOR THE KIND OF CHANGE THAT YOU MADE IN THE SHAPE OF THE CLAY. IT IS A REVERSIBLE CHANGE.

DO YOU THINK WE CAN CHANGE ANY OF THE OTHER PROPERTIES OF THE CLAY AND THEN CHANGE THEM BACK? WOULD ANY OTHER CHANGES BE REVERSIBLE? (Guesses.)

If the children suggest practicable changes, carry out their directions or allow them to show you. Modify the following according to the children's response.

DO YOU THINK WE COULD CHANGE THE COLORS OF THE CLAY BALLS? (Guesses.)

IF WE CHANGED THE COLORS, DO YOU THINK WE COULD CHANGE THE COLORS BACK? (WOULD IT BE A REVERSIBLE CHANGE?) (Guesses.)

HOW COULD WE FIND OUT? (Try it by experimenting.)

Distribute one craft stick to each child, and ask for speculations as to how the tongue depressor can be used to find out about color changes.

Direct the children to cut each of the balls cleanly in halves with the stick. Have them put each yellow half together with a blue half. They now have two nearly-identical plasticene balls. Have the children name the properties of the balls. They are similar in size, shape, odor, texture, color -- and especially, color distribution.

Ask the children if they can think of a way to change the color of the balls. Before you proceed:

SHALL WE TRY TO CHANGE THE COLORS OF BOTH BALLS? (With your guidance, children should be able to tell you that one ball should be set aside as a control.)

One ball should be set aside as a control. The other ball should be flattened into a pancake. The children should see that they have changed one property of the plasticene -- its shape. Ask the children how they can change the test object

back to its original condition -- that is, to make it like the control. When they have restored the test object to the spherical shape of the control object, have them compare the properties of the two -- colors will be mixed in the test object. If children observe this, ask them to try to separate the colors. Allow the children to play with the test ball, making objects that look very different from the control object. The more they manipulate the plasticene, the more the colors will be mixed. The children should not be told this while they work.

Have the children tell you some of the properties of their test objects. Compare them with the properties of the control object.

HOW CAN YOU CHANGE YOUR TEST OBJECT TO MAKE IT LOOK LIKE THE CONTROL OBJECT?

They will succeed in restoring it to the shape of the control ball. Suggest that they try to restore the colors of the test ball to match the control.

After the children have worked for a while without success, someone will probably say that it can't be done. Suggest that they stop now and put their balls aside. You might wonder how the colors can be separated, and ask the class to help solve the problem. Maybe if they thought about it until tomorrow they could discover a way of doing it.

The next morning return the balls to the children and ask for new ideas. Try again to separate the colors, and if they still cannot be separated, tell the class that we probably cannot return the test ball to the same color pattern as the control ball. But it is important that you encourage them to persist in whatever they are doing by adding:

MAYBE IF SOMEONE HAD SOME TOOLS AND WORKED
LONGER THEY COULD SEPARATE THE COLORS. WE
DON'T HAVE SUCH TOOLS, SO THIS CHANGE IS
IRREVERSIBLE.

Ask the children to suggest other changes which are reversible or irreversible.

Lesson 16: PROPERTIES OF AN ICE CUBE

COMMENTARY

Children observe properties of a melting ice cube, and then compare these with the properties of a control cube that was replaced in a freezer. The experience is designed to reinforce the children's understandings of control objects, and to have them see that changes can sometimes take place at "natural" (room) temperatures which do not take place at "unnatural" (freezing) temperatures.

MATERIALS

- 12 plastic containers (preferred) or 12 double styrofoam cups
- 12 ice cubes in a freezer tray

PROCEDURE

Divide the class into groups of three or four, so that each group can be given an ice cube in a container. Show the class the freezer tray of ice cubes, and have them watch as you lift each cube and place it in a container. As you transfer the cubes, discuss with the class that the compartments of the tray are about the same size and shape and that the cubes are all about the same size and shape. As you do this, describe to the class:

I AM PUTTING THIS ONE CUP CONTAINING AN
ICE CUBE INTO THE FREEZER. I AM GOING TO
GIVE ANOTHER -- JUST LIKE IT -- TO EACH GROUP.

After the ice cubes are distributed, have the class discuss the properties of the cube including temperature, hardness, odor, color, size, shape, and others. As the discussion progresses, the children will begin to include properties of the liquid that is appearing. Children should speculate as to the appearance of the ice cube that was returned to the freezer. Sustain the discussion until much of the ice has melted.

Take the control ice cube from the freezer and show it to the class. Some of it may have melted, and more will melt as discussion proceeds. But the control cube has not been handled by children, so it will look different from the cubes the children have examined. Have the children compare the properties of the contents of their cups with those of the control cube. Ask for explanations of the differences. A discussion of ways to keep the control cube so that its size and shape do not change might be appropriate. Children might consider how the properties of the cube could be restored.

IS THE CHANGE REVERSIBLE OR IRREVERSIBLE?

Lesson 17: PREDICTING CHANGES

COMMENTARY

Use either or both of these activities as opportunities for children to predict changes. This is conveniently incorporated within activities since changes take place over a relatively long period of time. In Activity A, children make use of a control object to observe changing properties of milk. Changes take place over the course of 48 to 72 hours, and observations are recorded on charts. This experience provides important background for later work with biological objects.

In Activity B, children tour the playground or locality to collect leaves and other natural objects. They assemble these as a collage (picture made by combining various objects) within a butcher tray. Each child is asked to predict changes that may take place in the items of his collage, and to observe it over the course of several weeks to confirm his predictions.

MATERIALS

-- Activity A --

- 8 oz. pasteurized non-homogenized (or raw) milk.
(Homogenized milk will not work.)
- 2 clear glasses of the same size or plastic containers
- plastic wrap
- 2 rubber bands or 1 marking pencil
- several large sheets of newsprint to be used as Observation Charts.

-- Activity B --

- 1 paper meat or fruit tray for each child
- glue
- collected leaves, weed flowers, acorns, stones, shells, etc.

PROCEDURE

Activity A

Shake the milk, then pour equal amounts (about one-half cup) into each of two containers. Mark the levels with rubber bands or marking pencil, and cover the containers with plastic wrap. Ask the children to describe the properties of the milk. Liquidity, lack of strong odor, non-transparency, and whiteness are among the properties they might observe.

Ask the class if they think any of these properties can be changed, and how they could be changed. After discussing this to the children's satisfaction, consider with them:

IF SOME PROPERTIES OF THE MILK CHANGE, HOW
COULD WE TELL? (Hopefully, children will suggest
that a control object can be used.)

Agree with this, and offer to put one container in the refrigerator as a control object. Tell the children that, in addition to a control object, they will use Observation Charts. Show them a large sheet of newsprint that will be used to make Observation Chart #1. In a vertical column, record the date, the time of day, and properties of the substances. Tell the children that they should plan to make new observations at the same time tomorrow, and appoint a monitor to remind the class at the appropriate time. Place the control object in the refrigerator, and set the other (test) object on a window sill or shelf -- preferably in a warm place.

Each day observations should be made at the same time. Put each daily observation on a new sheet of newsprint (Observation Charts 2, 3, and 4). The properties of the test object and the control object should be listed in parallel columns each day. Each day children should try to predict future changes in each object, the test and the control. Between 48 and 72 hours after the experiment started, the children should see these developments in the test object: yellowish cream will rise to the top and gelatin-like curds will form, and whey (a pale liquid) will separate from the curds. The properties of texture, odor, consistency and volume will change over time.

Have the children consider changes as reversible or irreversible.

CAN WE MAKE THE LIQUID MORE MILK-LIKE
IN COLOR? HOW? (Children might suggest
stirring it, and they should be asked to try this.)

CAN WE TAKE AWAY THE ODOR FROM THE LIQUID?
(Children should try any reasonable suggestions.)

Activity B

Give each of the children a paper butcher or vegetable tray. Have them start a picture in their trays with crayons. Tell them that they will collect things from outside to finish their pictures. Now, take the children out to the playground to collect only as many leaves, weed flowers, pieces of nuts, pine cones, berries, small twigs, and pebbles as they will need for their pictures. Use the MINNEMAST handbook, Living Things in Field and Classroom, as a help in finding, collecting and identifying many items, if you wish. In the classroom, have the children glue their collected objects to their trays to complete their pictures. If they like, children may share their objects and there is no need to use all the objects if there are too many. However, it would be good if you could subtly arrange for all children to have some objects in their collages that would change noticeably and some that would not.

Discuss their pictures with the children.

IF WE HUNG YOUR PICTURES UP ON THE
BULLETIN BOARD FOR SEVERAL WEEKS, DO
YOU THINK WE WOULD FIND THAT THEY
HAD CHANGED IN SOME WAY? (Guesses.)

DO YOU THINK THAT THE CRAYON COLORS
WOULD CHANGE? WOULD THE ROCKS
CHANGE? WHICH PROPERTIES OF THE ROCKS
WOULD CHANGE? (Guesses.)

WOULD THE LEAVES CHANGE? (Guesses.)

WHICH PROPERTIES OF THE LEAVES DO YOU
THINK WOULD CHANGE? (Color, texture, and
shape may be among children's correct pre-
dictions.)

HOW CAN WE FIND OUT IF ANYTHING HAS
CHANGED? (Guide the children to suggest
observing the pictures over a period of time.)

Allot a regular time each day for observing the pictures,
especially the changes and non-changes in them.

Lesson 18: CHANGING PROPERTIES OF BALLOONS

COMMENTARY

The three activities of this lesson include a demonstration of measurable change in size, a demonstration of a change in pattern, and an opportunity for individual experimentation by the children. An inflated and loosely fastened balloon is attached to the chalkboard; its shrinkage over a period of time is observed not by comparison with a control balloon, but by a before-and-after comparison with itself. This is accomplished by chalk marking the board at the ends of the balloon (or outlining the whole balloon) at given intervals. The chalk marks serve as a control object insofar as they record the balloon sizes at points of time before the end of the experiment. The chalk marks provide the children with the opportunity to compare the sizes of the balloon at any of the given points of time.

The ability to predict change is emphasized in Activity B, where children try to anticipate the change that will take place in a pattern you draw on a balloon before inflating it. In Activity C, children each have the chance to enjoy decorating, inflating, and deflating a balloon of their own.

MATERIALS

- 1 long balloon for each child (with several extra as replacements)
- 2 long balloons and 2 round balloons for demonstration
- paper clips
- masking tape
- several felt-tipped marking pens

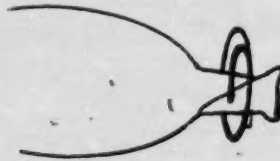
PROCEDURE

Activity A

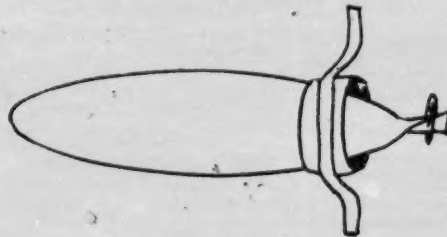
Show a partially-inflated long balloon to the children and ask them to name many of its properties, such as its shape,

color, size and springiness. Inflate the balloon in small stages, asking the children to name properties that change and those that do not.

Once the balloon is fully inflated, seal off the end with a paperclip. Since it is desirable that the balloon deflate gradually over the course of the day, it is important that you do not seal the end too tightly. The seal should not be so loose that you can hear the air escaping -- but it should be loose enough so that you can feel the leakage with your mouth when squeezing the balloon. Such a seal can usually be made by folding the open end upon itself or by twisting the open end of the balloon once and then pinching with a paper-clip, as shown below.



This balloon should now be taped horizontally to the chalk-board, but not in direct contact with masking tape, as masking tape will rip the balloon apart. Wrap a narrow paper sheath about the balloon and tape this sheath to the chalk-board. The tape and paper sheath should be near the blowing end.



ARE ANY PROPERTIES OF THE BALLOON CHANGING? WHAT ABOUT THE SIZE? HOW CAN YOU CHECK TO SEE IF THE SIZE IS REALLY CHANGING? (As the children watch the balloon, they should not observe a change.)

Let them suggest a method by which they can test whether the length of the balloon changes or not. They may suggest that two marks be made on the chalkboard, one at each end of the balloon. Have one child make such marks. Ask him to be careful not to touch or move the balloon. Have a few more children follow him immediately in making marks. You might find it helpful, too, to draw the outline of the balloon on the chalkboard as a sort of control for later comparison.

Then at regular intervals (of approximately 5 or 10 minutes, depending on how rapidly the balloon deflates) have children observe the length of the balloon and make new marks. Your questions should help them see that the marks do not reach or overlap with those made 5 or 10 minutes before.

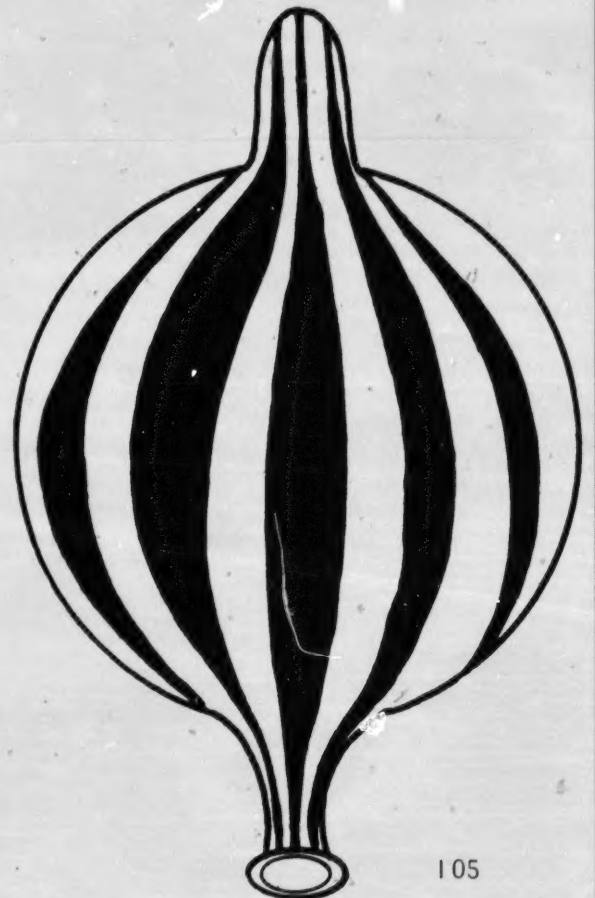
When the balloon has deflated considerably, ask the children to describe the change they have observed. By placing their hands at the chalk marks children can compare the sizes of the balloon at any two specified points of time.

Activity B

In the previous activity children observed changes in balloon size. Now the property, shape, is isolated for study. Select two of the designs suggested -- one for a long balloon and one for a round balloon. Using a felt-tipped pen, draw the appropriate design on one long balloon and on one round balloon. Hold one of the deflated balloons before the children to describe its properties, among them the pattern of the design. Hold the second balloon before them, and ask for their comparisons of the shapes, sizes and designs on the two balloons. Then ask the children to predict the appearances of each of the balloons when they are inflated.

WHAT WILL HAPPEN TO THE BALLOONS WHEN THEY ARE BLOWN UP?

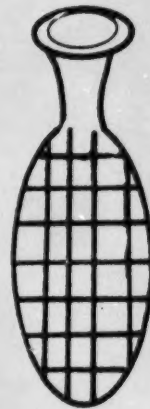
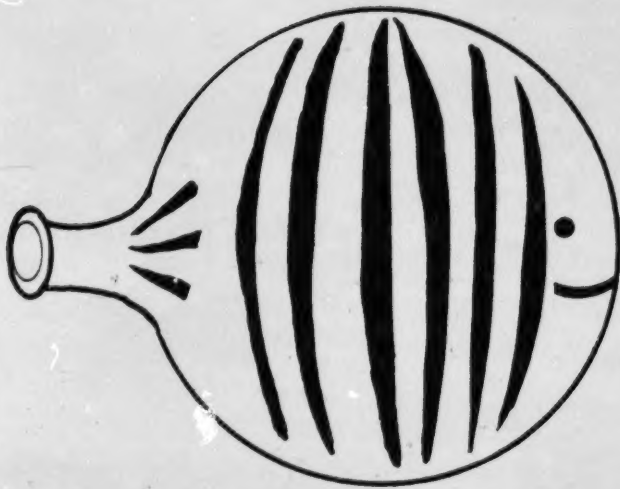
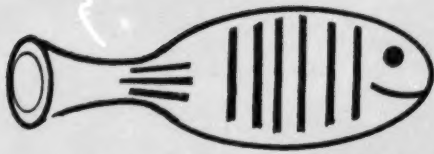
DESIGNS FOR LONG BALLOONS



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DESIGNS FOR ROUND BALLOONS



WHAT DO YOU THINK WILL STAY THE SAME?
WILL THE DESIGNS CHANGE IN SIZE? WILL
THEY CHANGE IN SHAPE?

Now inflate the long balloon. When the long balloon is partially inflated, the "tail" will have a markedly different appearance from the rounded portion.

WHAT HAS HAPPENED?

HOW DO YOU EXPLAIN IT?

WILL THE SAME THING HAPPEN TO THE DESIGN
ON THE ROUND BALLOON?

WHAT DO YOU EXPECT?

Follow a similar procedure with the round balloon.

Activity C

The children will enjoy experimenting with their own balloons. Give one balloon to each child and let the class repeat Activity A with paper and crayons at their desks. Each child can watch his own balloon change in size by comparing drawings of its outline at 5 or 10-minute intervals.

Later you might allow the children to decorate their own balloons with felt-tipped pens, and to observe the changes in the designs as the balloons are increased or decreased in size.

SECTION 4 CHANGING AND UNCHANGING PROPERTIES

PURPOSE

- Discovery by the child that although living organisms change continuously they retain a biological identity.

COMMENTARY

During their growth cycle all forms of life undergo many changes. Changes of the properties of living forms are continuous. By continuous we mean that changes are not apparent when observations are made in quick succession at any time during the growth process. Comparison of observations separated by longer periods may show change, but the biological identity of the living form is retained throughout the changes. If an organism develops by an orderly process of cell growth and multiplication, the biological identity of the organism is retained during its growth and development; that is, it remains the same individual. In this section children do not work with a precise definition of biological identity, but they are guided to observe that some properties of living forms change continuously.

The living forms to be investigated in Lessons 19, 20 and 21 are a plant, an insect, and finally the child himself. These lessons are to be done concurrently rather than in succession.

Since Lessons 19 and 20 take days or weeks to complete, other MINNEMAST lessons should be conducted during the same time. A good plan is first to set up the experiment for Lesson 19. While the children are making daily observations of the germinating seeds, they can also discuss and examine the changing insects. The plant observations take about one week to ten days and the insect observations two weeks to one month. However, the children will want to continue observing both the plants and animals, so do not discard any as long as they grow well and provide interest.

NOTE

Send copies of the letter on the next page home with the children as soon as you begin teaching this section. This will give the parents a day or two to find the items the children are requested to bring for Lesson 21.

Dear Parent:

In recent weeks, as part of his studies in the MINNEMAST unit, Observing Properties, your child has learned a great deal about the characteristics of various objects. He has learned that some properties of objects change and that others do not change. He has learned how to test for a hidden property, as in a live battery. He has found that some changes are reversible and that others are not. And he has had some experience in predicting the changes that will take place over a period of time (the melting of ice, the souring of milk, the drying up of a leaf).

Most of these studies were done with inanimate objects, but now your child will be studying the changes in living things. He will see how seeds germinate and grow, how mealworms change externally from larvae, to pupae, to beetles; and he will see how he himself has changed in size and appearance, and how he will continue to change.

It would be most helpful if, in the next day or so, you would send one or two of these items to school with your child:

- a picture of your child as a baby or toddler
- a small item of clothing he has outgrown, such as a shoe, a sock or a sweater
- an article of apparel (perhaps discarded by another member of the family) that is much too large for him.

By looking at pictures and by trying on clothing, each child will recognize some of the changes in size and appearance that are involved in human growth.

Any assistance you give to this lesson will be very much appreciated, but please do not send valuable items because many children will be handling them. (Be sure that the child's name is on each item so that it can be returned to you.)

Cordially,

Teacher

CHANGING AND UNCHANGING PROPERTIES
(Books appropriate for use with Lessons 19, 20, 21)

-- for teachers --

Marcher, Marion	<u>Monarch Butterfly</u>	Holiday, 1954
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-- for children --

Bancroft, Henrietta	<u>Down Come the Leaves</u>	Thom. Y. Crowell, 1961
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Branley, Franklyn	<u>Rain and Hail</u>	Thom. Y. Crowell, 1963
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Johnson, Ryerson	<u>Let's Walk up the Wall</u>	Holiday House, 1967
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Jordan, Helen J.	<u>How a Seed Grows</u>	Thom. Y. Crowell, 1960
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Krasilovsky, Phyllis	<u>The Very Little Girl</u>	Doubleday, 1953
----------------------	-----------------------------	-----------------

McClung, Robert	<u>Sphinx</u> <u>Tiger</u>	Morrow, 1949 Morrow, 1953
-----------------	-------------------------------	------------------------------

Schatz, Litta	<u>When Will My Birthday Be</u>	McGraw-Hill, 1962
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Showers, Paul	<u>How Many Teeth</u>	Thom. Y. Crowell, 1962
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Snavely, Ellen	<u>Shoes for Angela</u>	Follett Publishing, 1962
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Thayer, Jane	<u>Sandy and the Seventeen</u> <u>Balloons</u>	Morrow, 1955
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Tresselt, Alvin	<u>Hide and Seek Fog</u> <u>Hi! Mister Robin</u> <u>Maple Leaf</u>	Lothrop, 1965 Lothrop, 1950 Lothrop, 1962
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Zolvtow, Charlotte	<u>Sky Was Blue</u>	Viking, 1963 (Jr. Lit. Guild)
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Lesson 19: EXTERNAL CHANGES IN PLANTS

COMMENTARY

Plant growth and development is seen most dramatically in a germinating seed. The change from a small dry object to an elongated, rapidly-growing seedling with roots, stem and leaves takes place within a few days. Each child should grow his own plant and observe it every day. He should be helped to see that while all its visible properties change, the plant is at all times the same living organism.

The seeds listed below are easy to procure. They are relatively large and easy to handle, and they produce attractive young plants. Other seeds you or the children might like to try are grapefruit or flower seeds. Some teachers have used seeds from the Halloween pumpkin. Some parents may be able to supply seeds. You should plant a few extra seeds in case some of the children's do not grow. Commercial seed companies are your best source of flower seeds. Various kinds of beans and peas are packaged for groceries. These are inexpensive and can be used but you should try out a few first to make sure they are still viable. See the MINNEMAST handbook, Living Things in Field and Classroom, for further information.

If this lesson is begun on a Friday, results should be evident before the end of the next week.

MATERIALS

-- for the class --

- 1 roll of kitchen toweling. Do not use the poorer grade of hand towels from lavatories because some of these contain chemicals which may prevent germination.
- assorted seeds such as bean, beet, corn, cowpea, cucumber, okra, pea, soybean, pumpkin, radish, grass, and squash. (You may prefer to use DISPO seed pouches available from the supply house indicated in the complete list of materials in the front of this manual.)

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- story, "Surprise Package"
- morning glory seeds and narcissus bulb (optional)
 - for each child --
- small transparent glass, jar or plastic container
- magnifying lens

PROCEDURE

Give each child several different kinds of seeds, a section of kitchen paper toweling, and a small container. Tell the children they are going to plant these seeds in the containers, but first ask them to describe the properties of each kind of seed, including its shape, size, color, hardness, markings or grooves. Label and save some seeds of each kind. These seeds should not be germinated, but should be saved for reference by the children.

Now show the children how to plant the seeds. Have them press each seed against the inside of the glass or jar with a wet wad of toweling in such a way that the seeds can be observed as they germinate. If a single piece of paper toweling does not keep the seeds against the glass, stuff another piece in the center of the jar. The drawing shows the arrangement.



Seeds germinating in jar.

Tell the children that the paper toweling must be kept moist. They can do this by putting a little water in the bottom of the jar and then covering the jar with a small index card. (An alternative method is to fold the seeds inside moistened toweling and put this "package" in a plastic bag.) When the children have finished planting, have them mark or initial their containers. Put them in some convenient place in the classroom where the children can easily observe them. The seeds should germinate well at room temperature.

Remind the children to look at their plants every day and to record any changes with drawings or with marks that indicate measurements. They can keep these records on a folded sheet of newsprint or in a small notebook.

Ask questions that require the children to look closely:

WHAT IS HAPPENING TO THE OUTSIDE OF YOUR SEEDS?

IS THE OUTSIDE WRINKLED?

IS THE OUTSIDE SPLIT?

WHAT IS HAPPENING AT THE LOWER END OF YOUR SEED? AT THE UPPER END? AT THE SIDE?

I NOTICE THAT WE HAVE PLANTED OUR SEEDS IN MANY DIFFERENT POSITIONS IN OUR JARS. SOME SEEM TO BE TURNED ONE WAY, SOME ANOTHER. SOME SEEM TO BE PLACED SIDEWAYS AND SOME LENGTHWAYS, WHILE OTHERS ARE IN A SLANTED POSITION. DOES THIS SEEM TO CHANGE THE WAY THE ROOTS COME OUT?

DID ANY OF YOUR SEEDS SEND OUT ROOTS FROM THE TOP POSITION? FROM THE SIDE? WHAT DIRECTION DID THE ROOTS TAKE THEN? DID ALL THE ROOTS GROW IN THE SAME DIRECTION? WHICH DIRECTION? (After a while, the roots all grew down.)

WATCH TO SEE HOW THE STEMS GROW. DID THE STEMS ALL GROW OUT FROM THE TOP POSITION? WHICH WAY DID THEY GROW? DID THEY ALL GROW

OR TURN IN THE SAME DIRECTION? (Yes, after a while all the stems turned toward the top of the container.)

Some children may be able to remove their own plants from the containers carefully enough to draw the changing outlines in their record books. Each day after recordings are made, you may wish to have the class discuss briefly the changing properties of their different plants. Have them make comparisons of each germinating seed with its appropriate reference seed.

When the seedlings are two to three inches long and when the leaves and roots are strong, the class should examine these structures with magnifying lenses. A discussion should follow, as children identify changed and unchanged properties of the plant. You might extend the discussion by asking:

IS THE PLANT YOU ARE LOOKING AT TODAY THE
SAME PLANT YOU LOOKED AT YESTERDAY?

WAS THE PLANT YOU LOOKED AT TWO DAYS AGO
THE SAME PLANT YOU LOOKED AT THREE DAYS
AGO? HOW DO YOU KNOW?

References to their seed notebooks should help the children recall that the same plant was a seed a week before. The class should recognize that although the plant looked different at different times, it was always the same plant -- its biological identity was retained. If you use several kinds of seeds, the children can see that not only the original seeds, but also the seedlings, are different.

After the plants are a few inches high, you could terminate the observations, as plants will not continue to thrive in paper toweling. But the young plants could also be used for an interesting experiment and continued observations:

DO YOU THINK THESE PLANTS WILL CONTINUE TO
GROW WELL IN THIS PAPER TOWELING? (Predictions.)

WOULD THEY GROW BETTER IF WE PLANTED SOME
OF THEM IN SOIL? HOW CAN WE FIND OUT?
(By leaving some in paper toweling and planting
some in pots of soil.)

Have the children do this, if you wish, reminding them to
water the plants and to make observations of them from time
to time.

Read the story, "Surprise Packages," to the children and pro-
vide some morning glory seeds and a narcissus bulb or two
for them to plant and care for, as the children do in the story.
Children will enjoy watching the growth of these interesting
and beautiful plants.



SURPRISE PACKAGES

Sue and Sam are twins. They were talking about a very interesting event -- their birthday. Sam said, "Just think, Sue, tomorrow's our birthday. We'll be six years old! I wonder what presents we'll get. Just because we're twins, people always seem to think we want the same presents."

"Well, you want an erector set, and I certainly don't want one of those," Sue said. "I hope our presents are all different this time. But, even if they aren't, I can hardly wait!"

The next morning, Sam and Sue were up early. They hurried downstairs. On the table were two piles of packages and the piles looked very much alike. From Grandmother there was a blue sweater for Sam and a pink sweater for Sue. From Uncle Joe there was a coloring book for Sam and a coloring book for Sue. From Mother and Dad there was a pair of roller skates for Sam and a pair of roller skates for Sue. The two children looked at each other and laughed because -- just as they expected -- their presents were all very much alike.

"Well, let's go try out the skates," Sam said.

"Wait," Mother said, "there are two more packages here. They are from your Aunt Laura."

"Oh, goody, they don't even look alike!" Sue shouted.

"My package is small and it rattles when I shake it," Sam said.

"My present is in an envelope, and it rattles, too. I wonder what it could be?" Sue said.



Sam hurried to open his box. When he opened it, he looked disappointed. "Look at these things. They're brown and they look like onions," he said.

Sue was even more disappointed than Sam. Inside her envelope there were small, round, gray things that looked like no fun at all. "Aunt Laura always used to give us things that were interesting. Mother, do you know what these things are?" she asked.

"Yes, I think I know what they are," Mother said, "and I think -- if you're not in too big a hurry -- these presents will be pretty interesting too. But, here, let's see what Aunt Laura has written about them on the back of this birthday card."

Then Mother read:

Dear Children,

This year I think you are old enough to enjoy these presents, which are different from any I've ever given you. These presents will grow and change. These changes will take time, but there will be some surprises about them. Your Mother will show you how to take care of your presents, but she will not spoil your surprise by telling you what will happen.

With love,

Aunt Laura

The twins were very curious. These presents certainly were different from any they had ever received before. Besides, Aunt Laura's letter sounded so mysterious!



"What do we do with them, Mother?" Sam asked.

Mother brought out a shallow bowl and put it on the kitchen table. "Bring some of the smaller rocks from your collection, Sam," she said.

Sam brought the rocks, and Mother asked him to put them in the bowl so that they would reach nearly to the top. Sam did this. Then Mother helped him arrange the brown things in the rocks. Sue noticed that the rocks held them up straight.

"Now get some water and fill the bowl so that the water touches the bottom of the things," Mother said. Then she added, "Why don't we give your things a name? We can't just go on calling them 'your things' all the time."

Sam and Sue thought for a minute and then Sue said, "Let's call them 'our surprise packages.' Aunt Laura said there would be some surprises."

Mother put the bowl with Sam's "surprises" on a sunny window sill. "Now, Sam," she said, "you must see to it that there is always water in the bowl -- but not too much water -- only to the bottom of the surprises." Then she turned to Sue and said, "Well, Sue, shall we do something with your surprise? They look quite different from Sam's, don't they?"

"Yes, they're so small, Mother. I don't see what good they are. Do you think they will change as Aunt Laura promised?"

"Oh, yes," Mother said, "I'm sure your surprise will surprise you -- but it will take a while. Here, go put a few of Sam's rocks in the bottom of this flower pot!"



"You didn't ask me for any of my rocks!" Sam reminded Mother.

"Please, may we have a few of your rocks?" Sue asked.

Sam nodded and Mother said, "You will get them back later."

So Sue put a layer of rocks in the bottom of the pot. Then she filled it with soil from the yard. When the pot was nearly full, Mother told Sue to put in her surprises and to cover them with a little more soil. "Now pour a little water on the soil, very slowly," Mother said. When that was done, she put the pot on the window sill beside Sam's bowl.

"Now tell us what's going to happen," the twins teased and begged. Mother just shook her head and smiled.

"We might as well try out our new skates, then," Sam said. "She isn't going to tell us."

So Sam and Sue took their new roller skates and went outside to practice using them. They skated all morning. And in the afternoon there was a party with games and prizes. There was a birthday cake, too, and ice cream to eat with it. It was such an exciting day that the twins were very tired by bedtime, and fell fast asleep in practically no time at all.

But the next morning, they woke up -- bright as ever -- and hurried to the window sill to look at their surprises. "I don't see any change," Sam said. "I don't see anything different, either," Sue said.

The next morning, and the morning after that, they looked again. But still nothing had changed. "My surprise needs some water, I guess," Sue said. Sam thought his did, too, so they added a little water to the bowl and the pot.

On the fourth morning, they completely forgot to look at their surprises and Mother had to remind them.

When she did look, Sue called out, "Mother, come here and look. You come, too, Sam. Something is happening in my pot! Mother, what are those little white bumps with the gray caps?" Sue danced around with excitement.

Sam was excited, too. "They do look like little gray hats on top of some kind of white stems," he said.

"We'll have to watch and see what happens to those bumps," Mother said.

Then Sam looked at his bowl. Nothing looked different. He walked away, trying not to show his disappointment.

The next morning, Sue was delighted to find that the little white stems were longer. The hats were still on them. Then she looked at Sam's surprises and called out, "Sam, come here. Something is happening in your bowl, too!"

Sam came running and -- sure enough -- all around the edge of his brown surprises little white roots were beginning to show. And now every day, the first thing the twins did was to look at their surprises. Each morning there were changes.

Within another week, Sue found little green leaves pushing off the gray caps. The leaves began to unfold.

At the same time, Sam's surprises were getting more and more white roots that grew down and down among the rocks like thin threads or strings. And one day he found green leaves beginning to come up out of the tops of his surprises, too! "Look," he said



proudly, "they're flat and straight and green, like onion leaves. But they don't smell like onions at all."

After several green leaves came on Sue's surprises, she noticed that the ends of the stems had begun to twist and curl. "Why are they twisting like that, Mother?" she asked.

"These are vines," Mother said. "They need something to climb on. Let's fasten some strings from a stick in the pot to the top of the window and see what they will do."

Sue helped Mother fasten strings from the stick to the top of the window with tape. In just a day or two, the vines began twisting around the stick. Sue said, "Sam, if you watch hard enough, you can even see the vines winding themselves around." Sam laughed. He knew they weren't growing that fast.

Then one day the heart-shaped leaves on Sue's surprises were turned toward the sunlight. And another morning she saw a shape growing from the stem that was different from the leaves. She called to Mother to come and see it.

WHAT DO YOU THINK IT WAS?

Sam was watching his surprises, too. The roots and leaves were growing longer every day. He poked and peeked around inside the leaves, and suddenly his eyes were popping. "Mother, look," he called out, "I've found something that's not a leaf!" It was a long, bumpy, light green thing.

"What is it?" Sue asked, as she came running.

DO YOU KNOW WHAT SAM HAD SEEN?

That afternoon Mother had a long-distance phone call from Aunt Laura. She was coming to visit them very soon. The twins were very happy. "We will have something interesting to show her," Sue said, pointing to the surprises.

"Maybe it will be even more interesting by the time Aunt Laura gets here," Mother said.

Sue didn't understand that, when Mother said it, but the very next morning, there it was! One of the different shapes on Sue's vines -- one that was not a leaf -- had opened. It was a beautiful blue morning glory.

DO YOU KNOW NOW WHAT WAS IN SUE'S SURPRISE PACKAGE?

Sue was very excited, but Sam was a little disappointed about his surprises. They didn't have any pretty flowers on them as Sue's surprises did.

But on the very day that Aunt Laura was coming, Sam woke early and went downstairs to look at the plants in his bowl.

CAN YOU GUESS WHAT HE SAW?

There, right in his bowl, one of the knobby things had split down the side and a lot of white flowers had burst out. Sam let out a yell and everyone came running. After they admired the flowers on Sam's plant, Sue said, "I smell something good -- like perfume. Is



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it coming from your new flowers, Sam? Um-m-m, they smell lovely. Do they have a name, Mother?"

"Yes," Mother answered. "Sam's surprise package had bulbs in it and these lovely flowers grew out of them. The flower is called a narcissus."

When Aunt Laura arrived, the twins told her all about their surprise packages. "Thank you for sending such interesting presents," Sam said.

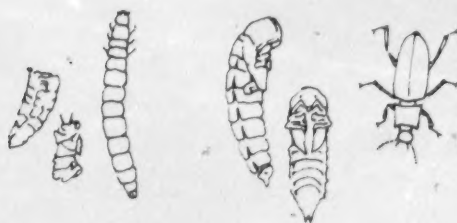
"And thank you for sending us each a different kind of surprise package," Sue said. "These were the only birthday presents we got that weren't alike!"

Then Aunt Laura gave them each a big hug.

Lesson 20: EXTERNAL CHANGES IN SMALL ANIMALS

COMMENTARY

The idea of the continuity of biological identity through rather dramatic changes in external form, which began in Lesson 19, is reinforced here in Activity A. The children observe mealworms changing from larvae to pupae to beetles (adults). The eggs are too small to be useful for observations here, but the children will be able to see three stages of the life cycle.



Pieces of cast skin, larva, pupae, and adult beetle of the mealworm (slightly enlarged).

If you have caterpillars (or cocoons formed by caterpillars collected for Lesson 4), the change in these little animals from larvae to pupae should be a subject of Activity B.

MATERIALS

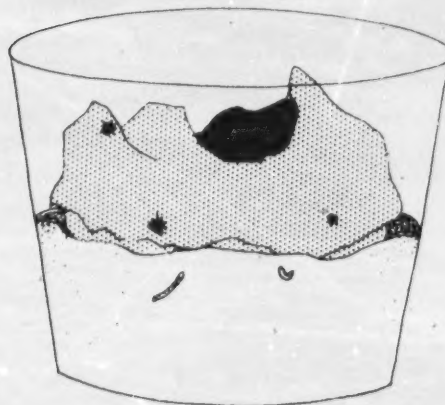
- 50 mealworms. Because mealworms are food for some pets, they can be bought at any pet shop or other store (such as a variety store) which sells live pets. They can also be purchased from biological supply houses, but this would probably prove more expensive. There are many good biological supply houses, of which the following are only a few: Turtox General Biological Supply House, 8200 South Hoyne Avenue, Chicago, Illinois, 60620; Carolina Biological Supply, Elon College, North Carolina; and Central Scientific, 1700 Irving Park Road, Chicago, Illinois, 60613.

- transparent, plastic shoe box or wide-mouthed glass or jar of at least one-quart capacity
- slices ($1/4$ to $1/2$ " thick) of fresh carrot or apple
- enriched baby cereal, cornmeal or dry bran cereal
- paper toweling
- small stone or block

PROCEDURE

Activity A

Transfer the mealworms to the large plastic container which has been half-filled with cereal. Put one or two slices of carrot or apple on top of the cereal. Crumple a paper towel on top of the food, then weight it down with a small stone or block so that nothing protrudes over the top or comes too close to the edge of the container. The larvae and adult beetles cannot climb the plastic sides, and the beetles do not fly, so these animals are easy to keep in jars. They will cluster under the fruit or vegetable slices, and they also will crawl into the paper towel and make holes in it.



Culture for maintaining mealworms.

Check the culture every other day or so and replace fruit or vegetable slices when they dry out.

Within a week or two mealworms (larvae) from the pet shop may change into pupae. In ten to fourteen days after that, small black and brown beetles will appear (the adults). Ordinarily there should be a time when three forms of the life cycle are present and visible in the container at once. These three stages in the life of the mealworm should give the children a very graphic example of changing properties in a living organism. As the changes take place, have the children observe and record the changes as they did with the plants.

It is easy to transfer mealworms to smaller plastic containers where the children can look at them through magnifying glasses. The children may notice that the adults can move rather fast at times, but that they do not jump or fly.

Some questions you might ask to encourage the children to observe more closely are:

WHAT COLOR ARE THE LARVAE?

HOW DO THEY MOVE?

HOW MANY LEGS DO THEY HAVE?

HOW ARE THE PUPAE DIFFERENT FROM THE LARVAE?

DO THE PUPAE HAVE LEGS? (Yes, they are folded inside.)

DO THE PUPAE CRAWL AROUND?

DO THEY MOVE AT ALL? HOW CAN WE FIND OUT?

Ask a child to poke one gently with a pencil.

HOW DO YOU KNOW THESE PUPAE ARE CHANGED FORMS OF THE LARVAE IN THE JAR?

DO YOU THINK THEY WILL CHANGE ANY
MORE? WHAT WILL THEY LOOK LIKE THEN?

WHAT COLOR ARE THE ADULTS, THE BEETLES?

HOW MANY LEGS DO THE BEETLES HAVE?

ARE THEIR LEGS JOINTED?

HOW DO THEY MOVE?

WHAT ARE THE LITTLE RODS ON THE BEETLE'S
HEAD? (Feelers.)

WHAT ARE THE FEELERS FOR? HOW CAN WE
FIND OUT?

Have a child poke a pencil or a finger gently near the beetle's
head.

HOW DOES THE BEETLE HOLD ON TO THINGS?

If the children can't find out by themselves, ask them to
look for the little hooks on the beetle's feet as it clings to
a pencil or finger.

DOES THE BEETLE HAVE WINGS? CAN IT FLY?

Let a beetle cling to one of your fingers, then hold it up-
side down and prod it gently. The disturbance will cause
it to spread its wings and try to fly. It won't be able to
fly, but the children can see the wings better.

IS THE BEETLE'S BODY ALL ONE RIGID PIECE
OR IS IT JOINTED?

If enough beetles survive, you might possibly raise a second generation, but this will take several weeks more. Eggs and young larvae are very small. As the larvae grow, they become nearly an inch long and so are easy to see. Eventually the larvae shed their old skins. Call attention to these empty brown skins in the culture.

Activity B

If a child collects a caterpillar -- along with the plant on which it is feeding -- and brings it into the classroom, the caterpillar will soon form a cocoon, probably in a few days. If the cocoon is cut open a couple of weeks later, the change from caterpillar to pupa can be seen. Nothing is likely to emerge from the cocoons that have been formed in the classroom, but the children can see this one change of form. See the MINNEMAST handbook for further suggestions.



Lesson 21: CHANGING PROPERTIES OF HUMANS

COMMENTARY

Here the children have opportunities to observe changing properties in themselves. In Activity A they describe themselves and make some predictions about possible changes in their appearance. In Activity B, using some of the items requested in the letter sent home at the start of Section 4, the children examine evidence of how they have changed and of how they will continue to change. In Activity C they use baby pictures to see some of the changes. Activity D, which concludes this unit, reviews some of the children's learnings in a story, "The Unidentified Object," which you read to them.

MATERIALS

- items brought from home by the children, which include: clothing too small for them, clothing too large for them, and pictures of themselves as babies or toddlers.
- story, "The Unidentified Object" (provided in manual)

PROCEDURE

Activity A

LET'S PRETEND WE ARE WRITING A LETTER TO A MARTIAN. WE WANT HIM TO COME AND VISIT US. IF HE CAME, HOW WOULD HE KNOW PEOPLE FROM HOUSES OR TREES? HOW COULD WE DESCRIBE OURSELVES SO THAT HE COULD RECOGNIZE US?

List the children's replies. Some suggestions might be that a person can run, has a head, clothing, etc. The descriptions of their hands, legs, feet, and so on, can be as detailed as you find appropriate. But specifically, children should recognize that humans have two legs and two feet, two arms and two hands, one head with a nose, mouth, two

eyes, two ears, hair and teeth. Put this list into the letter. At the close of the letter, invite the Martian to visit your class of children.

On the next day, read an imaginary reply from the Martian. Say that he would like to visit the class, but it will take him a year to arrive. The Martian wants to know if the children will still look the way they do now.

WILL YOU CHILDREN STILL LOOK THE SAME
A YEAR FROM NOW?

Review the list of human characteristics from the letter written to the Martian and ask the children to predict in what ways they may have changed. They will have changed in height, weight, size of feet, and number of teeth.

HOW DO YOU KNOW YOU WILL BECOME TALLER?

WERE YOU EVER SHORTER THAN YOU ARE NOW?

WERE YOUR FEET EVER SMALLER THAN THEY ARE
NOW?

HOW CAN YOU TELL THAT YOUR FEET ARE NOT THE
SAME SIZE THEY USED TO BE?

COULD WE TELL FROM OUTGROWN CLOTHING?
FROM PHOTOGRAPHS? FROM FAMILY CHARTS
OF YOUR HEIGHT AND WEIGHT?

IF YOU HAVEN'T ALREADY BROUGHT SOMETHING
YOU USED TO WEAR WHEN YOU WERE A BABY,
TRY TO BRING ONE THING TOMORROW. THEN
WE WILL TRY TO FIND OUT WHETHER WE HAVE
CHANGED AND WHICH PROPERTIES HAVE CHANGED.



Activity B CLOTHING AS EVIDENCE OF GROWTH AND CHANGE

Use the articles of clothing the children have brought to school. Mark them with their names or initials. Collect these items in a box. (Be sure to label all photographs and put them in an envelope in a safe place where the children will not see them until the next activity.)

One way to handle this activity is through dramatization. Ask for volunteers to play the parts of the parents. You will need to select the "children" from those who brought outgrown clothing. Tell the children to pretend that mother is unpacking their last year's clothes. "Mother" will ask the "children" to get the clothing from their box and try them on. "Children" can demonstrate how they have outgrown their old clothes. "Parents" can make appropriate comments, such as Father: "What, another pair of shoes! Why can't you wear these shoes?"

If someone has brought something too large, then "Mother" can say: "Let's see if this fits." "Mother" may then comment that the child will "grow into it" later. You will need to repeat this until all children who have brought articles and who want a turn have had it.

Activity C PICTURES AS EVIDENCE OF GROWTH AND CHANGE

Make temporary mounts of the photographs on separate sheets of paper. Ask the class to identify the person in each picture. The owner must not tell. Compare a few photos with the children whose pictures they are.

HOW HAS HE CHANGED?

HOW HAS HE NOT CHANGED?

If the parents of your children cannot supply many photographs use pictures of kittens and cats, puppies and dogs, calves and cows, etc., or a series of pictures of famous personalities at different ages (presidents, actors, etc.) or bring some of your relatives or some of yourself. The children will find it almost impossible to believe that teacher was ever a baby!

Activity D STORY, "THE UNIDENTIFIED OBJECT"

Conclude the unit by reading the story, "The Unidentified Object," to the children. Have them discuss the similarities and differences Terry and the caterpillar found in themselves and ask whether they can find any others.

Ryerson Johnson's book, Let's Walk Up the Wall, makes particularly good supplementary reading in connection with the subject of how humans are like and unlike other living things. If you can obtain a copy, by all means read it to the children.



THE UNIDENTIFIED OBJECT

THE UNIDENTIFIED OBJECT

A small worm-like object crawled across a stone. As he crawled, he looked up at the blue, blue sky. Suddenly his gaze was interrupted by a little girl, who was sitting in the grass looking up at the blue, blue sky too.

"Hi, there!" he shouted with all his might. "What are you? Are you alive?"

"Goodness," the little girl exclaimed, "I must be dreaming!" She looked all around, wondering where the voice came from. She could see only grass and a stone with a little worm-like object on it.

"What are you? Are you alive?" the worm-like object repeated.

The little girl, whose name was Terry, looked more closely at the worm-like object and pinched herself to see if she was awake. "A talking worm! Asking if I'm alive!" she said to herself in amazement. Then, to the object, she answered, "Of course I'm alive. Are you?"

"Certainly," responded the little fellow. "But that's what I was asking you," he added pertly. "I've seen you here before and I've wondered just what you are."

"I'm a person," Terry said.

"Is that something like me?" asked the talkative object.

"Oh, no. I'm a girl human being. I don't know what you are, but you certainly aren't a human like me. When I grow up I'll become a woman, and my brother will become a man. You look like a worm. You aren't like me at all. Our properties are different."

The worm-like object thought about Terry's statements. "Hmmm. I'm not so sure about all that," he finally said. "You see, I'm not really a worm, although I look like one right now." After another thoughtful pause



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he continued. "Let's compare our properties. Then maybe you can guess what I am. First of all, we have one property in common: 'we're both alive.'" Whereupon he took a tiny piece of paper and a blue pencil out of his special bag for carrying paper and blue pencils, put on his glasses, and began to make a list. He made two columns: PROPERTIES THAT ARE UNCHANGED and PROPERTIES THAT CHANGE.

"Now, girl-human-being," he shouted at Terry, "let's look at some of the properties we have. What about color? Do you change color?"

"No, I stay this color my whole life. How about you?"

"I change color four times," the object said proudly.

"Four times!" exclaimed Terry. "I can hardly believe it! What are the colors?"

"First I'm white, then I'm green, next I'm brown, and finally I'm orange and black. For color I can list you as 'unchanged' and myself as 'changed'. Does this clue help you guess who I am?"

"No, I still don't know," Terry answered.

"Well, let's try shape. What shape are you?" the worm-like object asked.

"I'm people-shaped, I guess. And I stay this shape all my life. I never grow any extra arms or legs. Do you change shape?"

"I change shape four times." The object was even prouder.

"Four times!" Terry exclaimed again.

"Yes. First I'm egg-shaped, then I'm larva-shaped, then I go into the pupa shape, and finally I'm an adult shape. So under shape I will mark you as 'unchanged' and me as 'changed.' Now, how about size? Do you change in size?" he asked very seriously.

"Yes, I certainly do change in size. First, when I was born, I was very tiny. But I grew and grew, and I'm still growing. I'll keep growing



until I'm grown up! I change my size quite a lot - from a little baby to a person as big as my mother. "

"Fine," the worm-shape said. "I'll mark you 'changed' in size. My size doesn't change as much as yours, but I change somewhat, too. In the egg stage, I start off as a small speck of an egg and I grow quite a bit before I change to my larva stage. When I enter my larva stage I eat a lot. In fact, I get rather stuffed and fat. My size changes then. But my biggest change in size is after my pupa stage. Then I change every which way. From a long worm-shape I change into a beautiful insect with wings. I'm absolutely gorgeous after this change!" he bragged.

"Now do you know what I am? "

"Not yet," Terry admitted, "but what other properties do you have?

"Let me see. How about symmetry? My left side is like my right side. I have one eye on one side and another just like it on the other side. Where I have one leg on one side I have another on the other side. "

Terry declared, "Now, there's a property where I think I'm like you! I have one leg on each side, too. So I must be symmetrical too! "

"I have symmetry throughout all the stages of my life, so I will put us down as 'unchanged' in symmetry," the worm-shape said.

"One question," Terry interrupted. "I was wondering if you were the same you during your whole lifetime. Since you change four times into four different colors and shapes, does that mean you are four different objects? "

"Certainly not! I'm the same me all my life," was the firm reply.

"Then we have that in common. I'm the same me my whole lifetime, too. I never change into a different girl. I'm always Terry and never Mary or Edith. "



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Terry thought and thought about the object's properties. Suddenly she realized what the worm was. "You're a caterpillar, aren't you? You are white in the egg stage, green in the larva stage, brown in the pupa stage, and then you turn into an orange and black Monarch butterfly."

"That's right! I knew it all the time. I just wanted to see if you knew it," the caterpillar said, laughing.

Then he rolled up his record sheet, folded his glasses, tucked them all in his special bag, and said, "This has been a very profitable discussion. I must tell the other caterpillars about you." Winking at Terry, he added, "Too bad you can't become a beautiful butterfly like me." And he turned and crawled away.

